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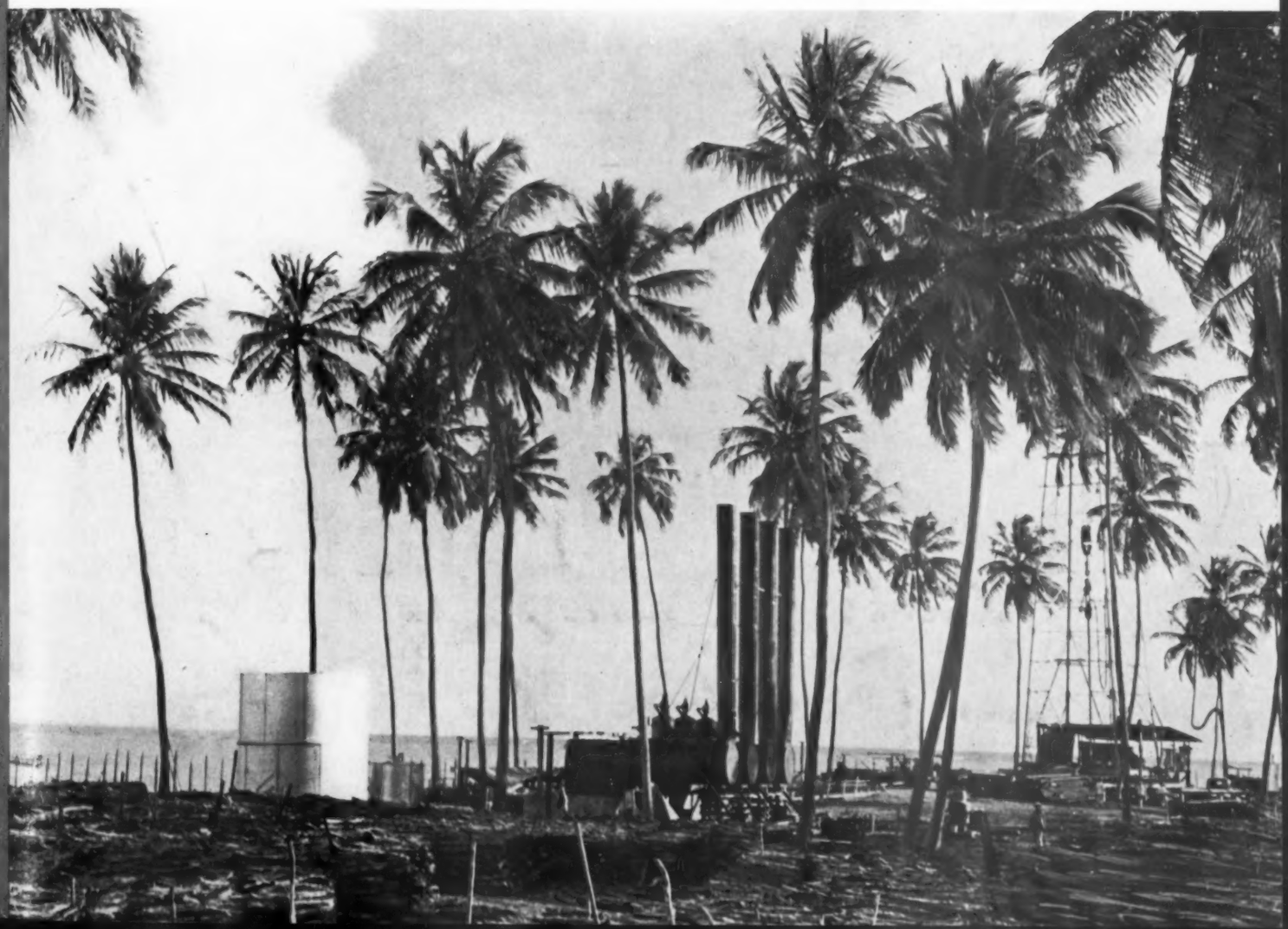

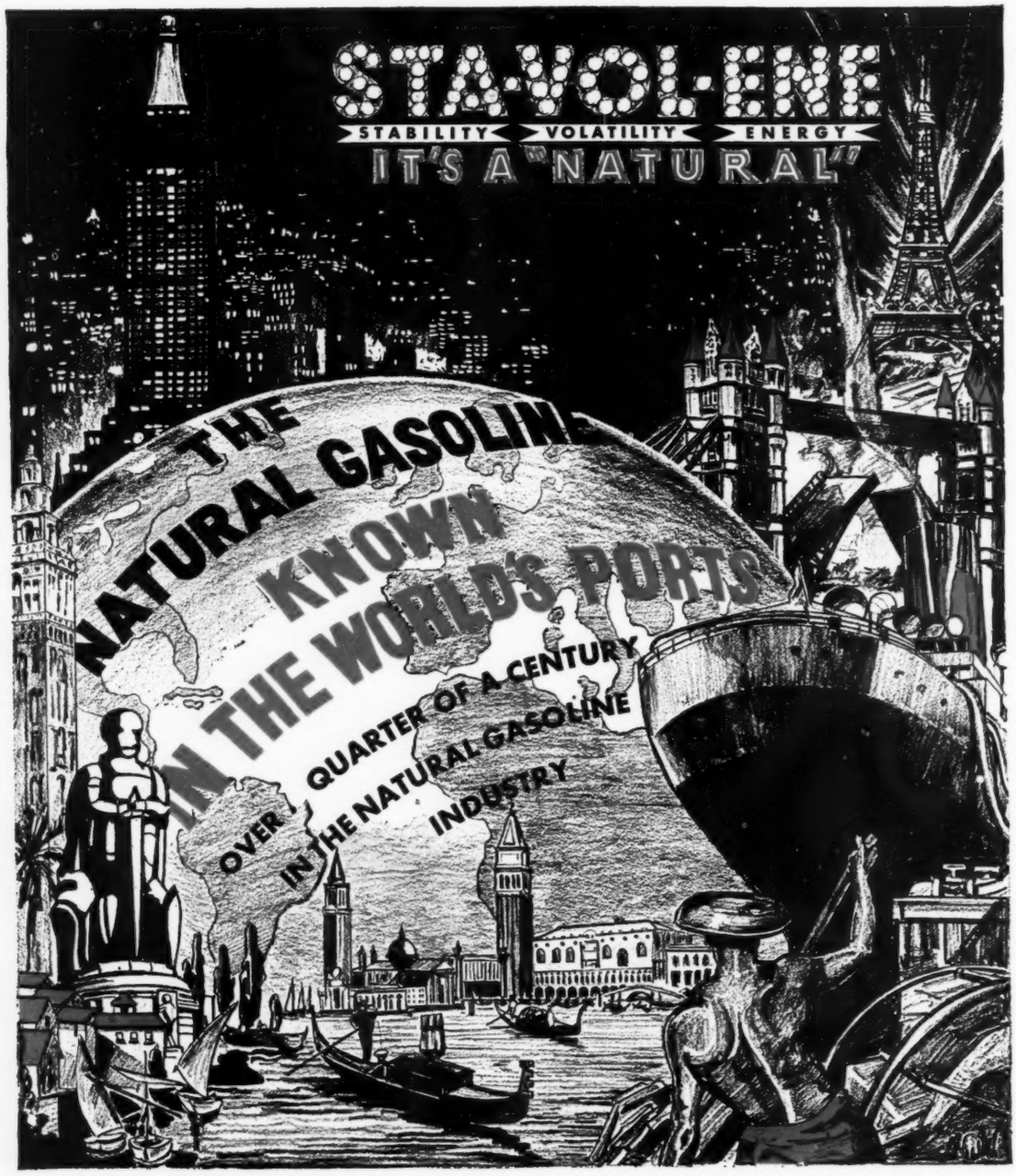
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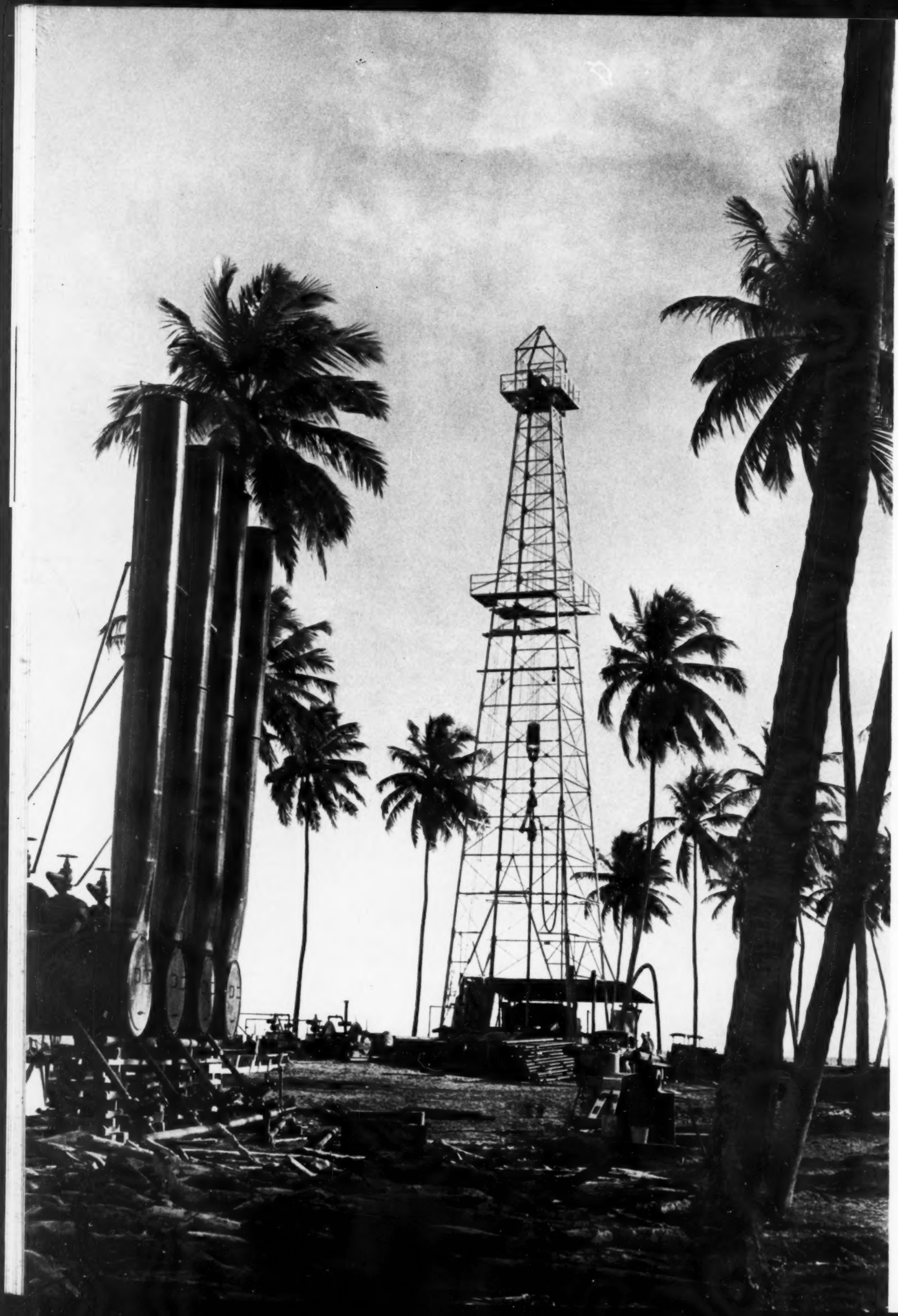

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CHANGING MARKET RELATIONSHIP OF GASOLINE AND FUEL OIL

RAPIDLY mounting motor fuel stocks in the United States are the subject of widespread discussion and concern throughout the trade. The concern deepens as weekly reports make it evident that the volume of gasoline in storage will exceed all previous records before the seasonal increase in consumption that begins with the approach of summer makes possible a change in the current upward trend.

This situation is regarded, rightly enough, as a most serious threat to market stability during the coming year. As stocks approach more and more closely to the limit of available storage capacity the none too secure gasoline price structure will be further undermined, bringing nearer the possibility of market disintegration at the time when it is most damaging, that is at the very commencement of the season of heavy demand.

In all the discussion of this problem few definite suggestions are advanced for remedying the situation complained of. Viewing with alarm accomplishes nothing except to disturb the peace of mind of the viewers yet the prevalent attitude appears to be that the condition of oversupply is inevitable. Beyond proposing that refiners cut their runs to stills in the winter months few suggestions are put forward.

Accumulation of surplus gasoline stocks during the colder months of course is no new phenomenon. Since the consumption of motor fuel fluctuates widely at different seasons some such accumulation is essential to the smooth and regular operation of refineries. Certain causes contribute however to the accentuation of the peak in supply from year to year and these must be taken into account in any practical effort to relieve the excess accumulation.

Two of these causes have been more or less constant over a series of years. One has been the rapidly growing consumption of fuel oil, particularly the lighter grades. In five years total demand for light fuel oil has increased over 60 percent as compared with a 45 percent increase in motor fuel demand. A substantial part of this growth comes from the increasing use of oil for domestic heating. This naturally is at its highest in winter and at its low point in summer, exactly opposite to motor fuel consumption. To supply the demand for fuel oil refiners must produce more gasoline than is needed during the winter season. Stocks of fuel oil rise in summer and fall in winter while gasoline accumulates in winter and its stocks decline during the warm weather. If demand for the two products were equally balanced this seasonal change would present no difficulties to refiners, but such a balance is never obtained under actual conditions.

A second factor which tends to increase the inequality between the two classes of products is the steady development of refining processes which make possible the conversion of a larger and larger percentage of each barrel of crude into gasoline. Twenty years ago only eleven gallons of gasoline were recoverable from a forty-two gallon barrel of crude by the refining methods then in vogue. Five years ago this percentage of twenty-six had been raised to forty-four. Today nearly forty-eight percent of the crude is converted into gasoline. This represents average performance. With the most improved processes still higher recoveries are obtainable. The 1,236,000,000 barrels of crude run to stills last year produced 596,000,000 barrels of gasoline whereas five years ago the same runs would have yielded only 540,000,000 barrels of the chief product. As motor fuel yields go up the portion of the crude remaining for other products declines in corresponding degree.

During recent months another factor, possibly a temporary one, has affected the situation. This has been the decline in exports of gasoline. In November and December these exports dropped some thirty percent below the average for the previous ten months of last year. A change in the character of the European war may alter this situation but at present the obstacles to international trade appear to be becoming more formidable rather than decreasing.

Added to these other influences has been the fact that extremely cold weather, as contrasted with the mild winters of the preceding two years, has pre-

vailed throughout most parts of the United States and has intensified the demand for furnace oil. In the eastern states a near shortage of fuel oil has prevailed in recent weeks and large consumers have been offering premiums well above current market quotations in order to obtain supplies. Taking all these causes together it is easy to see why refiners have been unable, or at least unwilling, to curtail their runs despite rising stocks of motor fuel.

A suggestion that presents itself to the outsider as an obvious corrective is to reduce the percentage of gasoline production in periods of low consumption and thereby to enlarge the output of fuel oil or other products seasonably in active demand. From the viewpoint of the refiner, however, this course is open to serious objection. Gasoline is still his most important and valuable product. Because it has long occupied the position of a by-product fuel oil has sold at a relatively low price. By lowering his production of gasoline the refiner would not reduce his costs substantially but he would be making a sacrifice in his expected return from the combined output of each barrel of crude.

It may be argued alternatively that the price of fuel oil is too low. Undoubtedly there is much to be said in support of this view and it is difficult to devise any other means than an advance in price to bring supplies into balance with those of gasoline. Some slackening in the growth of new installations and even a shift to other fuels in certain industrial plants where cost is practically the sole governing consideration could be regarded with equanimity by the petroleum trade if a satisfactory profit could be derived from a more stable demand.

There are practical difficulties, however, in the way of a prompt readjustment in price. A large proportion of the fuel oil used by industrial concerns and in domestic heating plants is sold on time contracts by which the consumer is guaranteed against a rise in price above a specified maximum. This may be bad merchandising since the seller assumes all the risk, but the practice is so firmly established that it could be eliminated only by a gradual process. More reliable knowledge of costs is needed. Few companies have cost accounting systems that show with any degree of accuracy the relative costs of different products and the marketing director is prone to assign costs in proportion to their established sales price. This may be a convenient method but is hardly an accurate one.

Partial relief for the shortage in fuel oil along the Atlantic seaboard has been afforded in the past few weeks by increased imports from the Netherlands West Indies under the commercial agreement with Venezuela concluded in December. Since this treaty permits the admission at a reduced rate of duty of only five percent of the total quantity of crude processed in the United States during the preceding year and since this five percent limitation applies to all crude and products it can have little effect in maintaining an equilibrium in market supplies. From the viewpoint of national economy the admission free of duty of oil for domestic and industrial heating would appear desirable since it would tend to maintain a better balance in the domestic market without interfering with oil domestically produced, but opposition to any tariff modification is strongly organized and might make such a step politically impracticable.

One possible means of ameliorating the threatened over-supply of motor fuel in the months that lie immediately ahead can be found by reducing runs to stills in the period beginning in March when the demand for fuel oil falls off materially and before the summer demand for gasoline reaches its full proportions. In this interval stocks of both products can be reduced with benefit to the general marketing situation and with no injury to any interest. In the longer perspective it appears that some readjustment in the relative prices of motor fuel and fuel oil may be needed to conform more nearly to their changing market importance. This is a problem to which members of the refining industry may well direct their attention.

The handsome Helis home in New Orleans' exclusive Audubon Place would do justice to the man whose ascendancy to the throne of his native country he reputedly helped to finance—King George II of Greece. Below, George Helis, now one of the oil industries' important independent operators, started as a penniless Greek immigrant in 1904.

GREEK EXPLORATION

in Hands of Louisiana's Bill Helis

By R. G. Drown Jr.

Greek Lad Who Came To America to Seek Fortune Found It in Coast Fields and Now Holds Concession Covering Practically Whole of his Native Land.

IN AN industry which has seen the rapid rise of many men from poverty to riches the career of William George Helis is still fascinatingly remarkable and unusual. In the past six years he has moved at top speed from one success to another. Known as the mystery man of Louisiana oil he has become one of the country's large independent operators and reputedly one of the wealthiest. That is only part of his success story for he probably is the only individual who holds an oil concession covering practically a whole country.

Arriving in the United States as a youth in his teens, a penniless Greek immigrant unable to speak a work of English, Helis has climbed to a position of outstanding influence among his compatriots in America. A few months ago, at the age of fifty-three, he returned to his native land to develop a concession authorizing him alone to explore for oil in every part of that country except a small district in the Epirus in which the Western Greece Oil and Asphalt Company holds exploratory rights granted in 1938. The area covered by the Helis concession is about 50,000 square miles in all.

While sentiment may have played a part in inducing Mr. Helis to extend his activities to the land of his birth his attempt to put Greece on the petroleum map of the world is no mere shot in the dark. He has long held the belief that oil could be found there and has fortified his opinion by reports of geologists and by geophysical surveys. His confidence appears to have been justified to some extent at least as it was reported in the Greek press in September that oil had been found in a test well near Kyllene. While details have been guarded Mr. Helis is known to have expressed to friends his belief that a large and important field would be developed.

A native of the small town of Tropea in southern Greece, where he was born in 1886, young Bill Helis arrived in New York harbor in 1904 at the age of 18 to seek his fortune.

True to his Grecian heritage, his first tentative steps toward a secure American future were in the restaurant field. He washed dishes, did odd jobs, migrated from town to town, from state to state. Some time was spent in New York, Missouri, Kansas, Pennsylvania, Oklahoma, Texas and California. The oil industry soon attracted him. He broke in as a "roughneck" in the mid-continent and later entered the promotional end of the business. In Pittsburgh, the center of some of his early operations, he met Betty Phillips. In 1911 they were married.

Two years later the young Greek, now 27 and with a series of financial ups and downs behind him, was granted his first naturalization papers in Indiana. During the World War, still hopefully on the move like many an oil man before him, he was in Kansas and joined the National Guard of that state.

Mr. and Mrs. Helis with four children born in as many different states, settled for a time in California where their sons and three daughters received college educations.

Just east of Greece, a large scale government financed exploration program is being carried on in Turkey.

In 1933, still casting around for the wealth that beckoned and eluded him in turn, he was in Memphis. Confident that he could make a real strike in the lush Louisiana fields, he interested a group of fellow-Greeks. Among them was a wholesale grocer, a restaurant man or two, a total of some 18 in all. The syndicate raised $20,000 with which they dispatched Bill Helis to New Orleans, which was to be the scene of his rise to power and influence extending to many fields of activity.

He arrived in Louisiana behind the wheel of a battered auto, with borrowed funds to tide him over but his faith in his destiny was soon to be rewarded. His first well was a gusher and the tide of black gold that flowed in enabled him to repay his Memphis associates tenfold within a few years. They realized some $200,000 from their flyer in oil with Helis and retain an interest in four of his wells in the Leeville field, some fifty odd miles southwest of New Orleans, which since his initial strike has become one of the richest in south Louisiana.

An active drilling campaign had begun there in the latter part of 1933 after the dome had been discovered by seismograph in 1930 by the Louisiana Land and Exploration Co. and the first commercial production was obtained in February, 1931, when the Texas Company's well, L. L. E. Leeville No. 2, came in flowing 360 bbl. a day from a depth of 3,028 ft.

During the first half of 1934 Helis reported five gushers in this field. Later that same year, with new Louisiana associates attracted by his increasingly successful operations, he formed the Lincoln Oil Company and became interested in the New Iberia field, where he was to bring in one big well after another and where he really made the bulk of his present fortune.

His lease on the Willy J. Bernard tract in the Little Bayou field in Iberia parish, which Helis sub-leased from the Iberia Oil Co. and Y. D. Spell in 1935, was referred to as "Louisiana's most prolific lease in the state's most prolific field." Not long ago he was reported to have 14 producing wells there, with Mayor Robert S. Maestri of New Orleans, former conservation commissioner of Louisiana, also interested in the property. Each of the 14 was rated more than 3,000 bbl. potentially.

In 1936 Bill Helis and his Canal Oil Co. drilled 16 wells and made commercial producers of eight of them. Total production for 1936 in this commercial field was 2,457,742 bbl., with the Helis interests having eight of the thirteen producing wells and the Texas Company the remaining five. The following year the Canal Oil Co., William Helis and Harry Fotiades, drilled eight wells and obtained production from all but one.

From the Iberia field Helis has been piping his oil to Bayou Teche and transporting it to New Orleans and to Baton Rouge by barge for refining. He disposes of salt water by converting an abandoned well into a salt water disposal well which handles approximately 1,052 bbl. per day.

At the close of 1937 the Louisiana department of conservation reported 30 flowing wells, seven pumping wells and five drilling rigs operating in the Iberia field where the once penniless immigrant had become, in three short years an important factor.

The conservation department's analysis of oil and gas wells completed in South Louisiana during the third quarter of 1939 credits Helis interests with two wells in the Golden Meadow field with a total daily initial production of 545 bbl.; three in the Iberia field totaling 1,349 bbl.; and 11 in the University field of East Baton Rouge parish amounting to 3,515 bbl. Additional wells in which he may be interested but which are not listed in his name are not included in this summation, but the 16 wells named contributed, in daily initial production, 5,409 bbl. to add their quota to the wealth this independent operator has amassed from South Louisiana's marshes.

Since he reached his present pinnacle of success, Helis has devoted much of his time and money to religious, patriotic, philanthropic and other interests.

Two of his daughters have been married since the family moved to New Orleans; one to a Hollywood motion picture executive, the other just November last to a New York attorney, himself a native of Greece. William (Buddy) Helis, Jr. is associated with his father.

The Helises maintain a spacious home in beautiful Audubon Place, one of the exclusive uptown residential subdivisions of New Orleans. They entertain aboard the yacht William Helis II and are awaiting the completion of another. Bill Helis has in the past few years invested heavily in industries and enterprises other than oil.

His benefactions have grown in importance with his own increasing stature in financial circles. In June, 1938, he sent a New Orleans troop of Boy Scouts to a summer camp for two weeks, accepting in return an honorary membership and the rank of "tenderfoot", which designation he had outgrown in business circles long before, and a certificate of "good citizenship" signed by scouting executives of his adopted city.

A few months later he donated a large silver and bronze permanent trophy which was awarded to the winner of a model plane race sponsored by the New Orleans junior chapter of the National Aeronautics Association.

He served as general chairman of arrangements and presided at the opening session of the American Hellenic Educational and Progressive Association (AHEPA) when that body, which has numbered 56,000 Greeks among its members, held its annual national convention in New Orleans in 1938.

During that meeting Helis pledged $1,000 toward maintaining the Pomfret Theological Seminary in Pomfret, Connecticut, which was opened in 1932 to prepare students for entrance into the Theological School of Halki in Constantinople, where priests of the Greek Orthodox church are trained.

As a special attraction of the AHEPA New Orleans conclave, he arranged a magnificent Queen's Ball which was carried out in the tradition of the Crescent City's famed Mardi Gras balls and staged a street procession, similar to the Carnival parades, in which the various elaborately-decorated floats bore the several contestants for the Queen's tiara and mantle. The Queen, chosen and crowned by Mr. Helis, was presented by him with an all-expense trip to Europe for herself and a chaperone.

Exhibiting keen interest in the advancement of the Greek church in America, Mr. Helis has traveled frequently in behalf of Greek religious interests, attended church conventions, and contributed handsomely to church and charitable enterprises.

Similarly, he gave much of his time to Greek fraternal and business groups and bent his energies toward aiding Greek immigrants to become acclimated in this country while making new friendships and forging business relations with fellow immigrants and erstwhile Greeks who had since become naturalized Americans.

He became a close personal friend of the Greek Ambassador to the United States, Dimitrios Sicilianos, visiting him in Washington and playing host to his eminent fellow-countryman in New Orleans on more than one occasion.

Mr. Helis is close to the "strong man of

Greece"—Dictator Metaxas. King George II, appointed him Greek consul for the southern United States and decorated him as Commander of the Ancient Order of the Phoenix.

Mayor Maestri recently named the Greek capitalist and oil magnate a member of a special civic committee to select and recommend the names of prominent Louisianians to whom fitting memorials should be erected and to plan and supervise the construction and dedication of monuments to them on the plazas which grace many of New Orleans' most important thoroughfares.

Now that he can well afford it, Mr. Helis is an enthusiastic patron of the arts. In 1937 he acquired an original "El Greco" painting, "St. Francis," executed in the late sixteenth century, for his private collection. Ambassador Sicilianos, who heard it was for sale, accompanied his friend when he went to inspect it and after he had purchased it for a reputed $25,000 Mr. Helis loaned it to the ambassador to be hung in the Greek legation in Washington. The work had previously been exhibited at the M. H. de Young Museum of Art in San Francisco in 1934 and at the Carnegie Public Library of Fort Worth the following year. It has long been one of Mr. Helis' ambitions to own an original work of his illustrious fellow-countryman who identified his painted masterpieces with the simple phrase, "The Greek."

Having become an intimate friend of state and national political leaders, including Postmaster-General Farley, it was natural that Helis should become a substantial contributor to the Democratic National committee. His donation to the Roosevelt war chest was listed, in the committee's report of January, 1939, as $5,000.

When he sought passage to Greece in late 1937 to investigate at first hand the possibilities for oil production in that nation, Helis found that he had been laboring under a misapprehension since 1913 in regard to his status as a citizen of the United States. He had been told by an Indiana election official and court officer in that year that the papers he had taken out at that time entitled him to full citizenship and had exercised the voting privilege since then in the nine states in which he had in turn established residence.

On August 20, 1938, the oath of American citizenship was taken by him before United States Circuit Judge Rufus E. Foster in New Orleans, though his service in the Kansas National Guard during the war would have entitled him to citizenship without the formalities of the naturalization procedure had he applied for it.

Since, and possibly because of, his rise to a position of wealth and influence Helis has been involved in several controversies with present and former associates. The stay-at-home members of the Memphis syndicate, who refused offers of their partner's later Louisiana associates to buy them out later filed a number of suits in federal court, more then one of which is still pending.

The contract between Helis and the interests from whom he leased one Iberia tract became the subject of a suit which has been of particular interest to oil men because of the point involved. At that time he closed his deal with A. L. Mitchell, A. B. Mhoon, Y. D. Spell and Bryan Ward all of Houston, and the Iberia Oil Co. in 1935, there was one producing well on the lease and the company was drilling a second. According to the petition in the suit which followed it was agreed that if either the company's second well or a well that Helis undertook to drill came in as a producer of more than 3,000 bbl. a day, "calculated on a 3/8 in. choke according to methods usually employed in gauging the capacity of oil wells," Helis had the privilege of buying the lease for $400,000. Otherwise the price was $300,000.

Leeville field in southwest Louisiana where Helis brought in his first well and which has since become one of the state's richest. Some 80 wells can be counted in this panoramic scene.

The company's second well was abandoned as a dry hole. Helis's well was a producer. He made tests and then exercised his option, as stipulated in the contract, within two days after the designated 15-day test period. A difference of opinion immediately arose as to the well's capacity. Helis, having agreed in the contract to pay 50 percent in cash and the balance in oil from the lease if he bought it, paid $200,000 as the cash payment but immediately had his attorneys attach it and went to court with the contention that though the company claimed the purchase price was $400,000, his understanding of the contract was that he could purchase the lease for $300,000. He claimed $50,000 was due him out of the $200,000 he had paid, contending that this amount represented the difference between the two cash sums involved.

The remainder of the $200,000 was released to the company and the $50,000 suit was subsequently abandoned by Helis but action was next brought against Helis by the company to recover $100,000 the difference between the amount paid it and the amount it claimed was still due.

Experts who tested the well testified it could produce greatly in excess of 3,000 bbl. daily on a 5/8 in. choke or larger, or if it were allowed to run open, but Helis maintained that the contract read that production was to be "calculated" on a 3/8 in. choke and the district court agreed with his contention.

On appeal, the appellate court reversed the earlier decision of the lower tribunal and declared that the wording of the contract imposed an impossibility, "as there is no well in Louisiana capable of producing 3,000 bbl. a day on a 3/8 in. choke." Helis was ordered to pay the additional $100,000.

The trial court had held that the contract called for production through a 3/8 in. choke and inasmuch as the well did not produce 3,000 bbl. a day through a choke of that size, Helis had to pay only $300,000. The appellate court ruled that if that was its meaning the contract would read "through" a 3/8 in. choke.

The U. S. Fifth Circuit Court of Appeals in April, 1939, refused to review its order requiring Helis to pay the $100,000 balance and in December the U. S. Supreme Court, reviewing the judgment against Helis, upheld the appellate court in refusing the rehearing and in its interpretation of the terms "calculation" and "production." The appellate court had ruled that the contract, which specified "3,000 bbl. a day calculated on a 3/8-in. choke" did not mean "production."

Ordering Helis to pay the additional $100,000, the Supreme Court on December 18 upheld the circuit court in holding that the test provided for in the contract "was not to measure the production through a 3/8-in. choke the amount the well was capable of producing."

The Helis interests have been active lately in eight Louisiana oil fields—Leeville, where Bill Helis got his real start, Iberia, where he

(Continued on page 50)

Petroleum Exploration in Brazil

National Council of Petroleum Carrying Forward Drilling Program in Three Regions Which Have Possibilities of Petroliferous Deposits—Well Now Drilling at Lobato Found Oil Showings.

Through the courtesy of the National Petroleum Council of Brazil, WORLD PETROLEUM is enabled to present an account of the organization which directs all petroleum affairs in that country, of the geological basis for the systematic search for indigenous oil supplies now being prosecuted and of the drilling operations now being conducted or contemplated. The following article by our Brazilian correspondent is published with the approval of the Council. While it relates only to the subject of exploration and drilling subsequent articles will deal with other phases of the Brazilian oil industry.—Editor.

Meeting of the National Council of Petroleum, Rio de Janeiro, Brazil. From left to right: Commander Helvécio Coelho Rodrigues, Dr. Érico de Lamare São Paulo, Dr. Domingos Fleury da Rocha, Captain Ibá Jobim Meireles, His Excellency, General Júlio Caetano Horta Barbosa, President of the National Council of Petroleum: Dr. Yttrio Corrêa da Costa, Dr. Alaor Prata Soares, Dr. Raul Mourão de Araujo Maia and Major Antônio Bastos. Dr. Ernesto Lopes da Fonseca Costa is not present in the group.

PRIVATE enterprises for petroleum prospecting in Brazil date from the beginning of this century. At the close of the world war, the Federal government, in view of the economic importance of petroleum, also decided to turn its attention to this problem.

In 1918, the Geological Service of Brazil started explorations in the areas considered favorable to the existence of petroleum deposits and the Federal Services have drilled 64 wells in the past 20 years, distributed in the following states:

São Paulo	22
Paraná	12
Pará	10
Alagoas	6
Bahia	6
Santa Catarina	6
Rio Grande do Sul	2

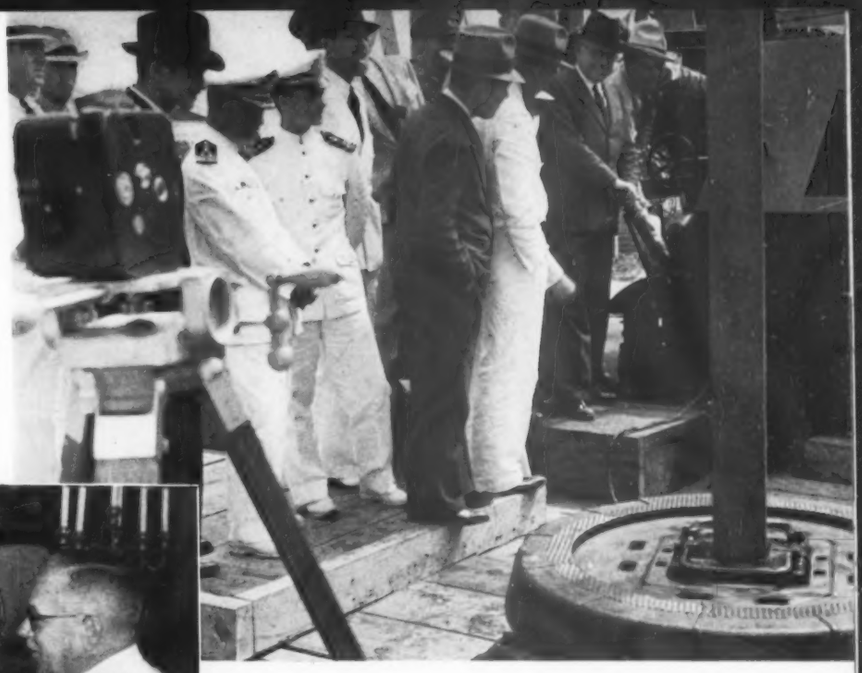
The Geological and Mineralogical Service of Brazil had charge of these explorations until 1933, when they passed under the direction of the National Department of Mineral Production, of the Ministry of Agriculture, where they remained until June 26, 1939. They were then transferred to the National Council of Petroleum.

This is an autonomous federal body, directly responsible to the President of the Republic, endowed with consultative and executive powers. It is concerned with all matters relating to the national supply of petroleum including the construction of pipelines, the distribution and marketing of crude petroleum and its derivatives as well as the refining of petroleum, imported or of national production, and in the latter case, of whatever source of extraction. This organization is also

responsible for carrying out the official explorations for deposits of petroleum and natural gases, as well as, when judged opportune, to go on with the exploitation and industrialization of the respective products.

The powers of the Council are extensive. It is authorized to install refineries, to fix the maximum and minimum limits of prices for the sale of refined products, imported or produced within the country, to grant permission for the importation of crude petroleum or its derivatives, to suggest to the government whatever measures pertain to the production, marketing, consumption, distribution, and establishment of stocks of these products.

Right, inaugurating drilling at Salvador in the State of Bahia on October 28, 1939.



H. E. Dr. Getúlio Vargas, President of the Republic, giving audience to General Horta Barbosa, President of the National Petroleum Council. Below, derrick under construction at Bahia, and right, below, Wilson Snyder slush pumps being unloaded at Bahia.

The Council includes an executive committee, a deliberative body, and various auxiliary technical services for business, accounts, etc. The executive committee is composed of the president, the vice-president, and one of the councilors. The members of the executive committee devote their entire time to the work of the Council. The president of the Council presides over the deliberative body, the other two members of the executive committee participating in it. They hold regular meetings once a week, and extraordinary meetings when necessary.

At present the Council consists of the following members: General Júlio Caetano Horta Barbosa, president; Engineer Domingos Fleury da Rocha, vice president; Engineer Yttrio Corrêa da Costa; Engineer Alaor Prata; Engineer Raul de Araujo Maia; Engineer Erico de Lamare São Paulo; Engineer Ernesto da Fonseca Costa; Major Antônio Bastos; Captain Helvécio Coelho Rodrigues, Councilors.

The three first named compose the Executive Committee. Councilors Alaor Prata and Raul de Araujo Maia represent, respectively, the industrial and commercial organizations, while Councilors Major Antônio Bastos and Captain Helvécio Coelho Rodrigues represent, respectively, the Ministries of War and Marine.

GEOLOGY

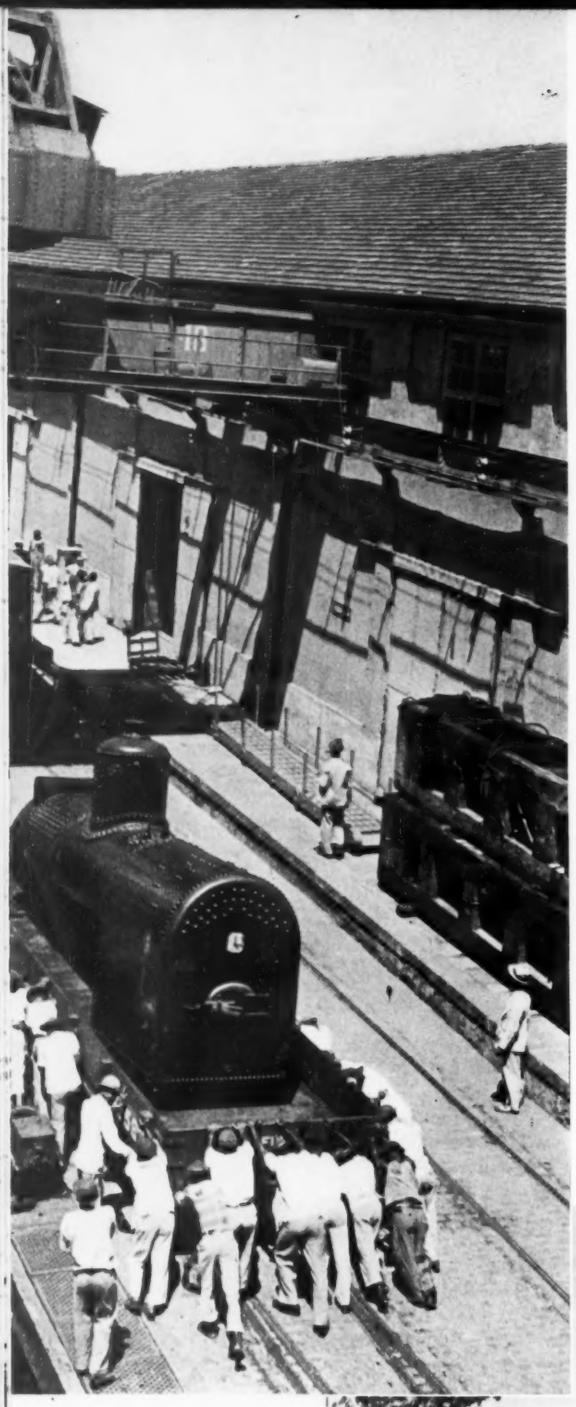
The areas recognized up to the present as the most favorable for the existence of petroleum deposits in Brazil are:

(1) Atlantic Coast, embracing the sedimentary belt of the coast, from the state of Rio Grande do Norte to the State of Rio de Janeiro.
(2) Western Acre, comprising the belt of the Territory of Acre, near the frontier of Peru.
(3) Southern Brazil, consisting of the Permo-Triassic belt, which extends from the state of Rio Grande do Sul to the State of Goyaz.

Besides the above, the immense sedimentary area of the Amazon basin and the basins of the rivers Parnaiba, Itapecuru, and Mearim, in the States of Piaui and Maranhao, may be considered.

On the Atlantic Coast a narrow belt of Cretaceous and Tertiary sediments extends along the shore of the States of Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe, Bahia, Espirito Santo, and part of the State of Rio de Janeiro.

Paleontological investigations show that during the Cretaceous period there was only one marine province of the Atlantic Littoral,



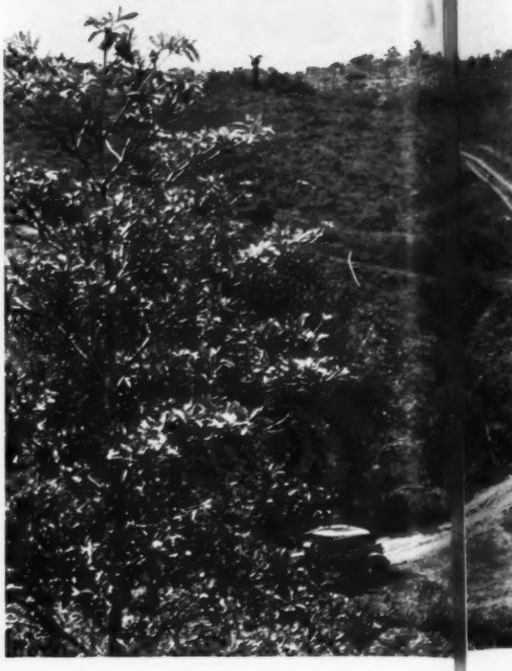
from the coast of the United States of America to the coast of northeastern Brazil, where the marine life presents a recognized uniformity. The species of Brazil, Mexico, and Texas are of one category only, and differ totally from the species occurring on the Pacific.

The Cretaceous beds of this belt have been subjected to movement, and have folds and faults, thus being capable of presenting structures suitable for the accumulation of petroleum.

Above the rocks of the Cretaceous system are laid those of the Tertiary, suggesting the existence of a Tertiary marine covering on the borders of the Atlantic and of the Gulf of Mexico in North America, and in the same way, in South America, from the mouth of the Amazon to the State of Rio de Janeiro, forming a narrow belt which has an average width of about 20 km.

The coastal formation resulting from this Tertiary sea has everywhere the same simple structure, and dips gently toward the sea.

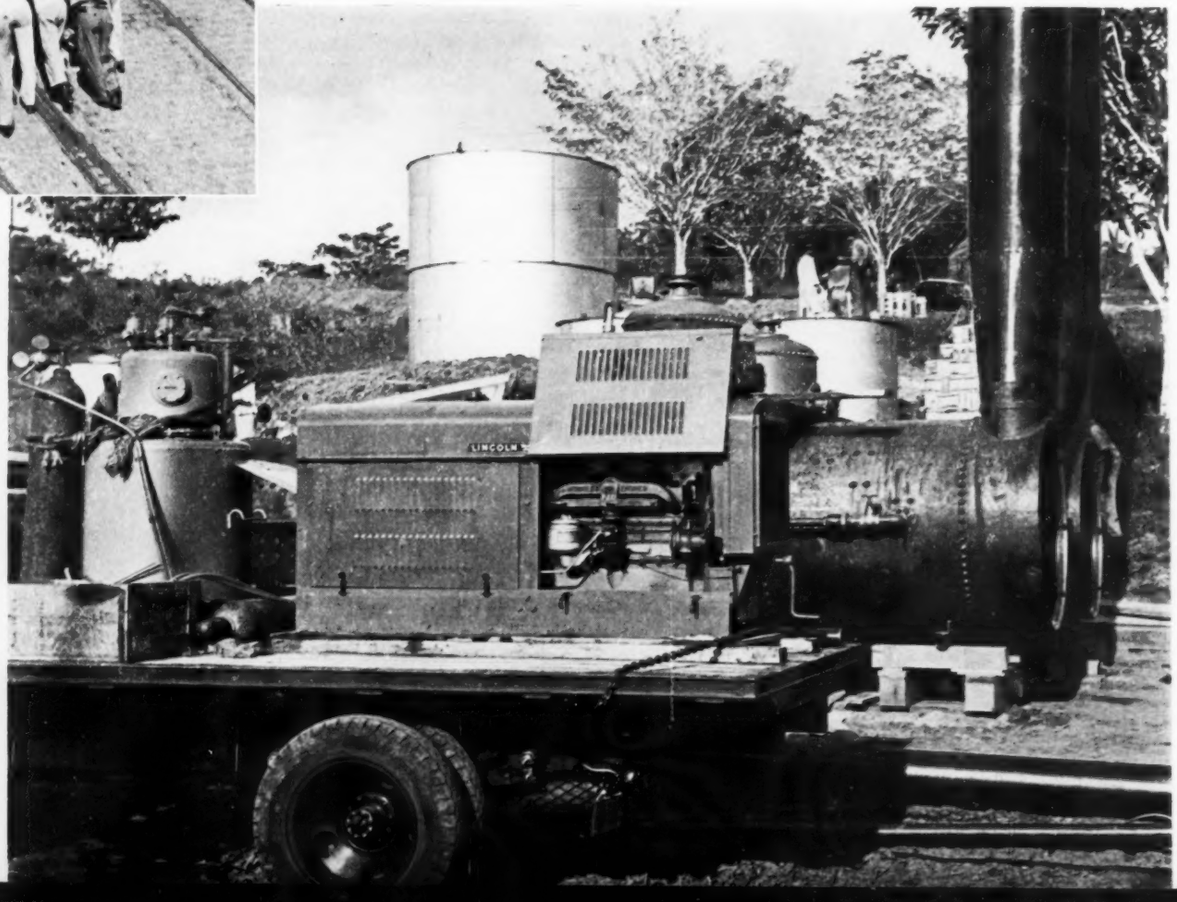
In the Cretaceous rocks of Bahia and in the Series of Alagoas,—Cretaceous or possibly Eocene,—traces of petroleum have been found impregnating the strata near the surface. Moreover, a bore-hole at Lobato near Salvador, capital of the State of Bahia, drilled by the Federal government, on January 23, 1939 reached an oil-bearing horizon, in Cretaceous rocks, at a depth of 702 ft. Because of that strike, the Cretaceous-Tertiary sedimentary belt, from Rio Grande do Norte to the State of Rio de Janeiro, came to be named by authors the "Petroliferous Province of the Atlantic Coast."



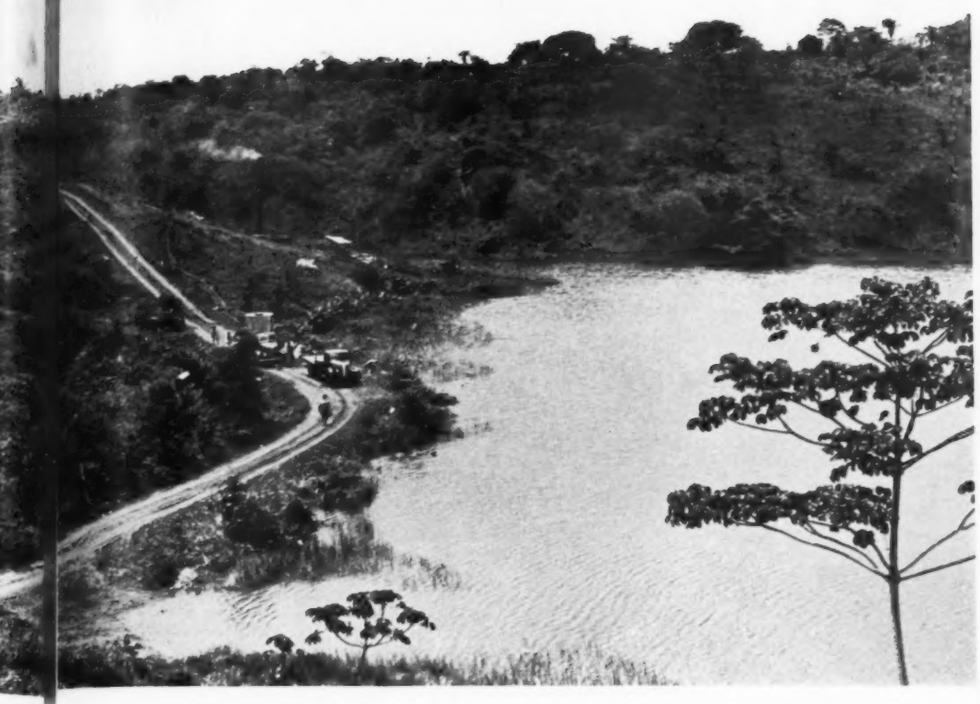
Above, on the road to B-3 location at Labato, a road which becomes almost impassable during rains, as witness below the tractor that slipped into the lake while trying to extricate a bogged truck. Right, "Oilwell" boilers at AL-1 in the State of Alagoas.

ACREAN REGION

In the huge Cenozoic sedimentary basin which extends from the lower Amazon River



Above, drilling equipment being unloaded at Recife, Brazil, for the current Government drilling campaign; Right, welding units at B-3 location, Labato.



to the Cordillera of the Andes, in the central zones, southeast and east of the State of Amazonas, and in western Acre, in Brazilian territory, no area that could with certainty be considered Cretaceous was known until a short time ago.

The formations of the central part of that basin are, in truth, nearly all Tertiary. In the sub-Andine belt of Peru they are constituted of reddish sandstones and other rocks called "petroliferous formation" by Brackenbush, "redbeds" by Singwald, and "Puca formation" by Steinmann.

Nevertheless, above this there is to be found, in Cruzeiro do Sul (Acre), near the Peruvian border, surrounded by these "redbeds", a small area of older sediments called "Formation of Moa", composed of sandstone, generally white, of fine granulation, compact at times, with bands of neat stratification, and also of yellow sandstone, presenting false beddings, (crossings), sometimes with lenses of greyish clay-like material, sometimes with beds of black clay.

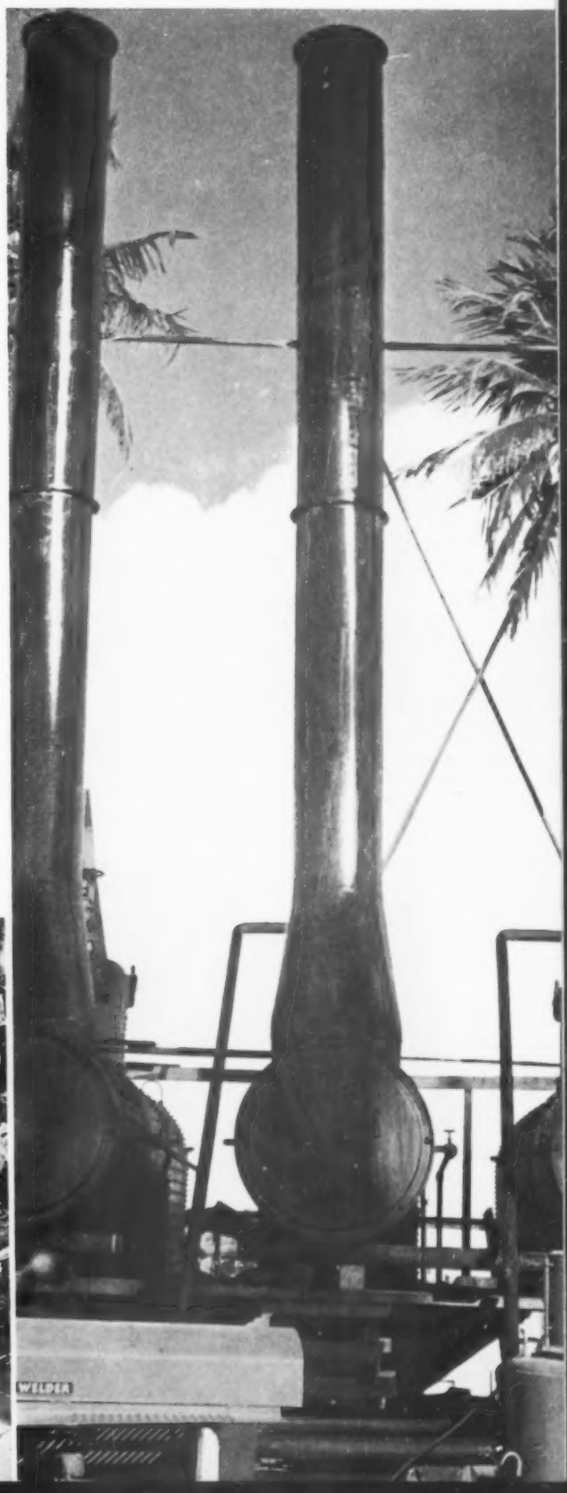
This formation, owing to its lithological characteristics and its stratigraphical position corresponds to the "Formation of Aguas Calientes", belonging to the Comanchean (lower Cretaceous), which occurs, as has been verified, on the Pachitea River, Peru. Both the formations of Moa and of Aguas Calientes are anticlines of the orogenic Andine phase. And since there is a large oilfield in the formation of Aguas Calientes, it is possible that the formation of Moa may be equally petroliferous.

SOUTHERN BRAZIL

During the first stage of petroleum explorations, the formations of the Permo-Triassic sequence in the southern part of the country were the main subject of investigations and drilling. In petroliferous formations in Brazil, within this immense area, the Devonian system must be included, so that an interesting column for research would be formed by the Devonian, the Permian, and the Triassic systems.

The discovery of petroleum on January 23, 1939, at Lobato, in the Reconcavo of Bahia appeared to justify further exploratory efforts in that region which seems favorable to the existence of commercial deposits, and in general in the "Petroliferous Province of the Atlantic Coast."

The National Council of Petroleum drew up its plan of petroleum prospecting, for immediate execution in the Atlantic Coast



Above, Dr. Nero Passos surveying a 17 in. rotary, 60 in. travelling block at the B-2 location in Bahia; Left, spudding B-2, ceremonies attended by Gen. Horta Barbosa and Dr. Landulfo Alves, Interventor of the State of Bahia; Below, left, swivel and elevators on AL-1, Maceio, State of Alagoas.

area and also in the Acrean region of the Brazil-Peru frontier.

In the Atlantic Coast area, the Reconcavo in the State of Bahia, and the district of Maceio in the State of Alagoas were chosen for the preliminary investigations.

BAHIA

The Bahia Reconcavo presents Cretaceous formations of the Bahia group, consisting of shales and sandstones, which become conglomerate, with fresh water fauna. On the whole it is evident that the repeated alternations of bituminous shales and conglomerates indicate local variations of fresh, brackish, and salt water deposits.

The beds of the Bahia group outcrop on the shore of the Bay of "Todos os Santos" and extend about 100 km. northward inland in the region termed "Reconcavo". They are formed by soft shales and sandstones which become coarse conglomerates ascribed to the neocomian group, with fish, reptile, and mollusk remains. These beds present folds and faults, which do not facilitate the study of the geological column.

The National Council of Petroleum has put three drills into operation in the State of Bahia as follows:

(1) A National Supply Co. cable tool drilling outfit capable of a depth of 5,000 ft. installed at Ponta de Itapagipe, in the locality known as Penha. The well was begun on the 25th of October, 1939, and on December 4 had reached a depth of 332 ft.

(2) A rotary drilling outfit of Oil Well Supply Co., with a capacity of 4,500 ft. installed at a place called Vila Militar, Salvador, where drilling started on the 30th of last October. On December 6 this drill had bored 3,302 ft.

(3) A rotary of the same manufacture, with a capacity of 4,500 ft. installed at Lobato, 300 ft. away from the well which on the 23rd of January 1939, registered the existence of petroleum at 702 ft. This drill began operations on November 16, and on the 6th of December had reached 917 ft. In this case also, oil was struck at about 700 ft.

Because of having reached the greatest depth and because of its presenting the most geological interest, the following resume is given of the stratigraphic column of Well B—2 drilled by the rotary drill at Vila Militar. The classification of the rocks is provisional,

and will be definite only after petrological and paleontological studies.

0 to 265 ft. — shales
265 to 334 ft. — conglomerate
334 to 351 ft. — hard shale and boulders
351 to 386 ft. — hard shale and shells
386 to 394 ft. — hard shale
394 to 427 ft. — shale and sand showing oil and gas
427 to 446 ft. — broken slaty shale
446 to 1297 ft. — shale and hard shale
1297 to 1309 ft. — hard shale, streaks of hard sand
1309 to 1551 ft. — shale and hard shale
1551 to 1564 ft. — hard shale, conglomerate (and chert?) bottomed in red quartzite
1564 to 1962 ft. — shale and hard shale
1962 to 2652 ft. — shale with streaks of hard sand (Drilling work in progress).

ALAGOAS

On the coast of this state occur the rocks of the series of Alagoas, in the following localities: Graça Torta, Riacho Doce, Barra de Camaragibe, and Maragogi. They are shales with fish fossils of estuarian origin, associated with the upper Cretaceous or with the Eocene (Tertiary).

The formation is characterized by folds, faults and fractures, with possibilities of petroleum. For the purpose of exploring it, the National Council has installed at Ponte Verde, to the east of Maceio, a rotary outfit of the Oil Well Supply Co., capable of drilling 6,000 ft. The bore-hole was begun on October 30th and on December 6 had reached 2,808 ft.

The work being carried out in the States of Bahia and Alagoas has been entrusted, under contract, to Drilling & Exploration Company, Inc., of Los Angeles, California, the president of which is J. E. Brantly. This well-known firm of specialists in work of this character has carried out petroleum prospecting not only in the United States but in Mexico, Venezuela, Colombia, and Peru. These drilling operations will be conducted by crews of American technicians who have come to Brazil especially for this purpose.

The drilling operations in the region of Acre are now being carried out with a small drilling rig while the preliminary work in preparation of a methodical plan of research to be started in 1940, is being done.

The National Council of Petroleum, at the same time that it is conducting drilling operations at Ponta Verde, in the State of Alagoas and in Penha, Vila Militar and Lobato, in the State of Bahia, is going ahead with investigations into the geological structures in the areas being bored, and will soon begin geophysical prospecting by the seismographic method of reflection, in order to determine new locations. Other equipment will be acquired for the drilling operations in the Territory of Acre.

Top, AL-1 location with 122 ft. Parkersburg derrick, Wilson Snyder No. 18 slush pumps and "Oilwell" 27½ in. rotary and hoist; Right, completion of cementation at B-2; and below, hooking up slush pumps for B-2.

AVIATION GASOLINE REQUIREMENTS T

By B. Orchard Lisle

Military and Commercial Planes Using More 100 Octane Fuel—European Wartime Demand About 53,500 Bbl. Daily—Oil Industry Expands Manufacturing Facilities to Meet the Rapid Growth in Consumption.

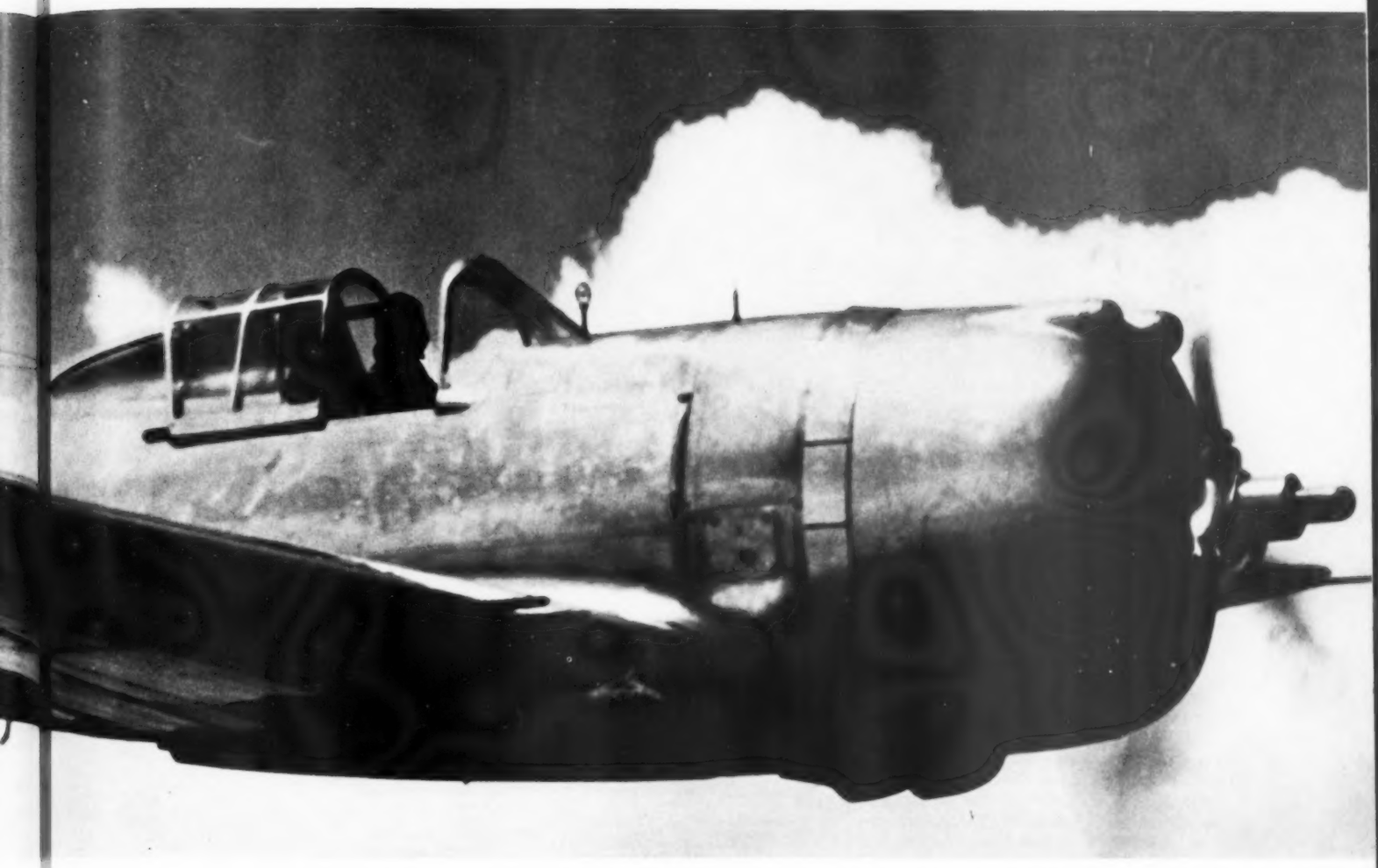
ANNOUNCEMENT by the United States Government that it plans to increase the first line air forces to 6,000 units under army control and a similar number as a fleet auxiliary to the Navy by July, 1940, forecasts a greatly increased demand for 100 octane fuel. Developments of such automotive engines will depend upon the general availability of this grade of fuel and the increased requirements of military aviation, operating exclusively on 100 octane gasoline, in addition to the steadily growing commercial consumption, undoubtedly will absorb the productive capacity of the many new plants under construction.

The American-built Curtiss Hawk 75A pursuit plane (right) is one of the French airforce 320 m. p. h. 1,100 h. p. ships which outflew famed German Messerschmitts in early engagements of the present war according to French reports.

The chart at top of page 35 illustrates the relative importance of American commercial, military and private flying as consumers of the various grades of aviation gasoline. During this period the requirements of private enterprise maintained a small lead over the total demand by the nation's armed forces up to the end of 1938, but the year just past saw the consumption by scheduled air lines step back into second place. Private flying has remained fairly constant in quantity, although falling behind in proportion to the total consumption.

Recent years have shown an increase in the proportion of consumption in the 100 octane classification. This has been due in part to the use of this type fuel for take-off by commercial aircraft, but to a greater degree has been the result of rapid improvement in the quality of aviation fuel used by the United States army, navy, marine corps and coast guard planes. In 1930 only 44 percent of the gasoline

TREND TO HIGHER OCTANES



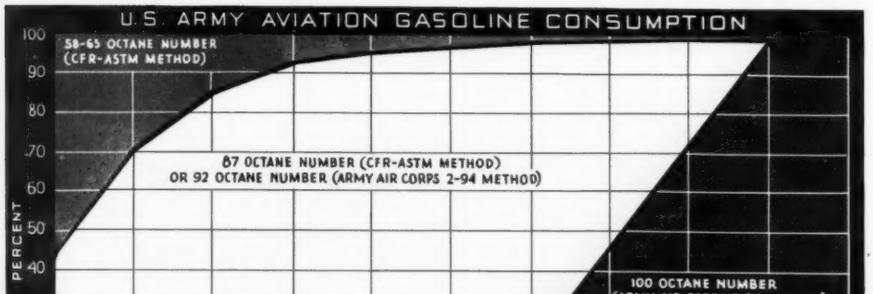
© Curtiss Wright Corp.

used by the army air corps, for example, was rated at 92 octane (army method) while the balance of consumption consisted of grades which were considerably lower. By 1934 the higher quality represented about 95 percent of the gasoline consumed. It was around this time that it became possible to produce iso-octane as a commercial proposition, although it was still too costly for use by private enterprise, and in 1935 the army introduced the use of 100 octane aviation gasoline to the extent of about five percent of its requirements. So important were the resulting improvements obtained in military efficiency that it was immediately decided to make use of this fuel to the eventual exclusion of all other types, as supplies became available. The rapid progress made in this direction is brought out in the chart at top of page 34 and by the middle of 1939 only 100 octane fuel was being used by the army. Similar substitution of fuel types has taken place in the air corps of the other American fighting forces so that the statistics of last year's military consumption which are given in Table I represent, for the most part, this high octane fuel.

Increase in passengers flown in the United States, presented graphically on page 34 would at first seem to conflict with the decline in number of planes from the high of 600 in 1930 to only 345 in 1938, but this is due to the fact that passenger capacity per plane has been increased to such an extent that fewer planes have been required. At the same time, engineering improvements have permitted faster travel, and therefore more trips per plane in a given time, with very little change in fuel consumption.

With exception of the take-off, overland air traffic has yet to find justification for the use of 100 octane gasolines but there has been a definite trend toward the higher ratings among the three commercially used grades of 80, 87 and 90 octane fuel (C. F. R.-A. S. T. M. method).

The long non-stop transoceanic flights of Pan American Airways' big flying boats, however, render use of the best fuels essential for economical operation. Naturally, the efficient employment of this fuel requires certain modifications in engine design, but that has produced no great difficulties. Higher octane fuel permits an alternative of increased supercharging or higher compression. When supercharging is employed, change-over from 87 octane fuel to 100 octane results in a 20 to 25 percent gain in power output but does not vary the fuel economy. On the other hand, increasing the compression ratio when switching to the higher grade of fuel enables the owner to obtain a decrease of fuel consumption by 13 percent at the same time as the power output is increased by a like amount. On this basis, the Pan American clippers flying to Honolulu on 87 octane gasoline would require 2,400 gal. in their tanks, whereas with 100 octane fuel and increase in compression there would be a



saving of 320 gal. This would mean that the deadweight of the flying boats would be decreased and that the pay load could be increased by 1,960 lb.—a substantial amount when dealing with aircraft efficiencies.

This experience with high octane gasoline on the Pacific run was of considerable value to Pan American when it started its service to Europe, and the trans-Atlantic clippers are using fuel doped with 3.5 cc. to 4.0 cc. of tetraethyl lead and rated at 95 octane by the C. F. R.-A. S. T. M. method, which corresponds approximately to the military fuel rated at 100 octane by the army method and which is leaded to a maximum of 3.0 cc.

Undoubtedly, the United States is the center of the world's aviation industry—just as it leads in the production, refining and consumption of petroleum—so that what American aircraft manufacturers are doing today will have an important bearing on the aero fuel demand of tomorrow. Colonel John H. Jouett, president of the Aeronautical Chamber of Commerce, has just completed a survey of plant expansion throughout the country and reveals that the present annual production capacity is 15,000 airplanes and 16,000 engines of all types, but that aircraft companies are increasing their output rapidly. He states that more than $7,000,000 had been spent during the first six months of 1939 in adding to engine manufacturing space, while additional plant now under construction involves the investment of another $10,000,000. In 1940 the plants will be able to produce at the rate of 25,000 annually the 1,000 horsepower engines needed for military and heavy transport work, besides being able to meet the requirements for the lighter power plants.

From other sources it was learned that during 1940 the industry, as it now is being tooled-up, should have an output of more than 35,000 engines of all types while about 25,000 planes will be produced in the same year. Military aero engines are not limited to a maximum of 1,000 horsepower by any means, as a 2,500 horsepower plant has been developed and entered production while one of the engine companies has a 42-cylinder liquid-cooled unit on the boards which is reported to develop about 4,000 horsepower.

Table I

U. S. Military Consumption of Aviation Gasoline
(Barrels)

Year	Army	Navy*	Coast Gd.	Total
1938	575,619	425,997	40,420	1,042,036
1937	484,119	346,568	39,351	870,038
1936	426,143	263,954	.....	690,097
1935	371,167	225,026	.....	596,293
1934	317,738	199,387	.....	517,125
1933	344,000	201,379	.....	545,379
1932	268,143	193,726	.....	461,869

* Including Marine Corps.
Based on figures from Quartermaster General and Chief of Army Air Corps, U. S. War Dept.; Bureau of Supplies and Accounts, U. S. Navy Dept.; Division of Finance, U. S. Coast Guard.

Table II

U. S. Aviation Gasoline Consumption
(Barrels)

Year	Military[1]	Transport	Private	Gd. Total
1939[3]	1,514,000	1,186,000[4]	265,000	2,965,000
1938	1,069,932[2]	1,078,815	242,882	391,629
1937	870,038	986,295	252,815	2,109,148
1936	756,152[2]	992,311	248,845	1,997,308
1935	698,081[2]	891,919	254,387	1,954,387
1934	563,026[2]	598,483	229,306	1,390,815
1933	519,894	626,828	210,979	1,357,701
1932	461,869	563,975	245,085	1,270,929

[1]Includes Marine Corps [3]Estimate
[2]Includes National Guard [4]Six months, 592,085 bbl.
Based on figures from U. S. Civil Aeronautics Authority; Navy Dept.; Army Air Corps; and Coast Guard.

Such radical developments are incorporated into the first line aircraft of the United States' fighting forces while all designs prior to that date are relegated to second line classification. Under former regulations of the Aeronautical Board of the War and Navy departments,

Table III

World Military Air Forces and Gasoline Consumption in 1937*

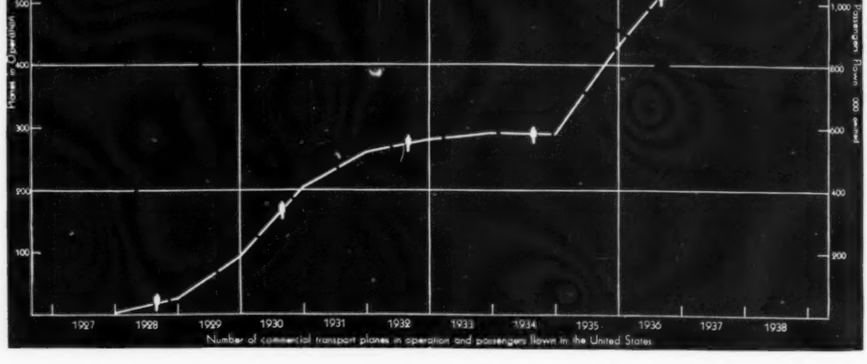
Country	Personnel (No.)	Planes (No.)	Gasoline (Bbl.)
British Empire	57,040	4,800	1,337,000
France	54,000	4,700	1,309,000
Germany	50,000	4,500	1,253,000
Italy	50,000	4,500	1,253,000
Soviet Union	150,000	4,500	1,253,000
United States	35,000	3,400	946,000
Japan	40,000	3,000	835,000
Roumania	15,000	1,000	281,000
Spain	5,200	500	240,900
Poland	8,000	400	112,000
Turkey	10,000	400	112,000
Sweden	4,700	300	105,000
China	2,500	250	70,000
Belgium	2,370	225	62,000
Chile	2,040	225	62,000
Argentina	1,750	175	48,000
Greece	6,750	150	42,000
Denmark	1,100	90	25,000
Brazil	4,000	75	20,000
Others	3,500	350	100,000
	502,950	33,540	9,465,000

*Extracted from tabulations compiled by V. R. Garfias, R. V. Whetsel and J. W. Ristori, Foreign Department, Cities Service Oil Company, N. Y.

such designs could only be sold abroad one year after delivery of the second production model to the American Government, by which time the design itself would be about two years old. Thus the American-built pursuit planes in French service which have been reported to outclass the famed Messerschmitt fighters of Germany are comparable to America's second line, or reserve, aircraft. Recently, however, the Board has advised the aircraft industry of revisions in its policy on release of aircraft and their components of more recent design.

This should be of interest to the oil industry because it means that the military air forces abroad will be employing a greater number of airplanes designed for efficient performance on fuels of the highest possible octane rating, whereas a large proportion of them now operate on what amounts to an ordinary commercial grade.

With the assistance of Commander Leland



P. Lovette, U. S. N., Mr. F. B. Brinkley of the Civil Aeronautics Authority, and recourse to data made available by Major R. Ernest Dupuy, U. S. A., the writer has been able to compile some interesting statistics in connection with the military air forces of the United States and 43 other countries, from which approximation of the 1939 aviation gasoline demand has been obtained. These figures apply to the situation as of the outbreak of the European War, and do not account for the war losses or considerable additions by purchases in America, since revision of the Neutrality Act, or other neutral countries.

Table III has been extracted from calculations made in 1938 by Garfias, Whetsel and Ristori of military aviation strength and fuel requirements and makes an interesting comparison with the writer's estimates of current demands in Table IV. Incidently, allowance has been made by the writer with regard to German requirements in light of reports that about 20 percent of the Reich's airplanes are powered by Diesel engines. Because first line European aircraft are comparable with American second line planes, the United States has been credited with 100 percent replacements. Actually, second line and reserve units are unofficially believed to exceed this proportion, but there is no information on this situation for release at the present time and all official information mentions first line aircraft only.

Of the warring nations, it is interesting to note that Great Britain and Japan are both credited with fewer pilots than planes; both countries, however, have an unduly high proportion of other aeronautical ratings which, undoubtedly, includes students who subsequently have received their wings. Adding the pilots derived from Empire sources, there is little doubt that by this time Britain is capable of manning her air armada.

The estimates in Table IV would indicate that during the first stages of the European War an average of about 53,500 bbl. of aviation gasoline were consumed daily by the military forces of both neutrals and belligerents in Europe. This compares with some 29,000 bbl. daily peacetime demand for these states. In considering the belligerents it has been necessary to omit Poland, as that country survived as a separate entity for such a short time after the outbreak of war that comparable data is not possible; however, Britain, France, Russia, Germany and Finland consumed an average of 64,400 bbl. daily between September and December compared with 20,500 bbl. a day prior to declaration of war—an increase to 314 percent of peacetime needs.

With replacements equalling losses through enemy action, the 1940 military demand by the five belligerents seems likely to amount to 17,000,000 bbl., while intensification of hostilities may result in this figure being trebled. In addition, there is the aviation consumption of Diesel oil on the part of Germany. Nazi economists have placed their ultimate wartime requirements of this latter fuel at 10,500,000 bbl. per annum, but it is doubtful that prosecution of the first four months of the war has necessitated the use of a tenth of that amount.

The availability of imported aviation gasoline to the Franco-British forces is obvious and it is therefore more interesting to consider the problem of supplies with regard to Germany. There are two schools of thought concerning German oil supplies. One, of which one of the leading proponents is Dr. Gustav Egloff, declares that the Reich is critically short of gasoline and that what fuel production is available is of a quality inadequate to the task. He said, not so long ago,

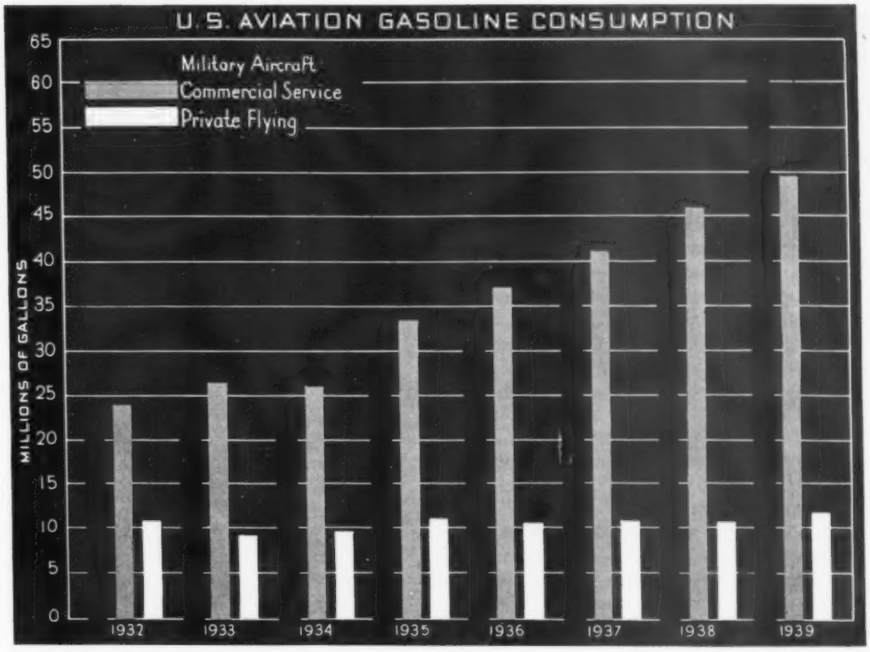


Table IV

World Gasoline Consumption in 1939 by Military Aviation

Country	Pilots	Other Ratings	First-Line Aircraft: Bombers	Fighters	Observation	All Types	Gasoline Consumption, Jan.–Aug. 1939 (Bbl.)	Gasoline Consumption, Sept.–Dec. 1939
Germany	10,000	55,000	1,360	1,296	400	9,612[1]	1,440,000	2,080,000
United States	6,300	21,700 +	61 Squad.	22 Squad.	36 Squad.	7,370[4]	1,009,000	505,000
Great Britain	5,000	83,000	800	2,10	400	7,100[5]	1,015,000	1,846,000
Soviet Union	8,000	51,000[3]	1,420	3,030	1,100	5,550[19]	794,000	890,000
Italy	8,000	54,000	800[6]	960	400	3,960[8]	566,000	284,000
France	6,000	58,650	770	1,200	730	3,700[7]	429,000	962,000
Japan	2,700	116,800[3]	640[9]	565	165	3,070[10]	1,430,000	718,000
Jugoslavia	1,600	7,000	.....	.....	.....	1,060[11]	150,000	80,000
Turkey	600	7,800	150	300	100	900[12]	126,000	65,000
Roumania	1,000 +	7,000 +	.....	.....	.....	800[13]	114,000	60,000
Poland	1,000	4,000	.....	.....	.....	800[14]	115,000	?
Lithuania	(5,200 all ranks)		.....	.....	.....	770	110,000	58,000
Switzerland	.....	.....	.....	.....	.....	550[15]	79,000	46,000
Spain	800	4,600	.....	.....	.....	500[16]	71,000	36,000
Argentina	200 +	1,800 +	.....	.....	.....	470[16]	67,000	35,000
Belgium	400	3,000	1 squad.	6 squad.	5 squad.	400	57,000	32,000
Netherlands	500	4,000	175	200	.....	375	54,000	30,000
Sweden	(5,200 all ranks)		.....	.....	.....	250 + [17]	35,000	20,000
China	400	2,100	.....	.....	.....	250	57,000	29,000
Brazil	500	3,500	.....	.....	.....	214	31,000	17,000
Thai (Siam)	.....	.....	.....	.....	.....	207	29,000	15,000
Chile	160	2,000	.....	.....	.....	200 +	28,000	14,000
Iran	.....	.....	.....	.....	.....	200	28,000	14,000
Finland	.....	.....	.....	.....	.....	150	21,000	17,000
Canada	.....	.....	6 squad.	2 squad.	6 squad.	150	21,000	11,000
Greece	.....	.....	.....	.....	.....	118	17,000	9,000
Norway	.....	.....	.....	.....	.....	100	14,000	8,000
Latvia	(350 all ranks)		.....	.....	.....	100	14,000	8,000
Esthonia	.....	.....	.....	.....	.....	100	14,000	8,000
Mexico	200	500	.....	.....	.....	100	14,000	7,000
Portugal	.....	.....	.....	.....	.....	100	14,000	7,000
Denmark	200	900	.....	.....	.....	90	13,000	6,900
Colombia	.....	.....	.....	.....	.....	90	13,000	6,400
Peru	.....	.....	.....	.....	6 squad.	80	11,500	6,000
Eire (Irish Free State)	.....	.....	.....	.....	.....	71	10,000	5,000
Bulgaria	.....	.....	.....	.....	.....	70	10,000	5,500
Australia	.....	.....	.....	.....	.....	60	9,000	4,800
Outer Mongolia	.....	.....	.....	.....	.....	50	7,000	3,500
French Indo-China	.....	.....	.....	.....	.....	40	5,800	2,900
Iraq	.....	.....	.....	.....	2 squad.	30	4,500	2,300
Venezuela	.....	.....	2 squad.	1 squad.	.....	30	4,500	2,300
Egypt	.....	.....	.....	.....	.....	30	4,500	2,300
Cuba	.....	.....	.....	.....	.....	2 squad.	4,000	2,000
New Zealand	(294 all ranks)		12	6	10	28	4,000	2,000

[1] Includes 3,056 first line reserves and 2,500 second line reserves; about 20 percent of the German planes are powered by Diesel engines.
[2] Includes 3,800 second line reserves.
[3] Does not include semi-military pilots or parachute jumper units.
[4] Allows for 100 percent estimated second line replacements, but does not include catapulted aircraft from warships.
[5] Included 350 flying boats.
[6] Includes 1,800 first line reserves.
[7] Includes 1,000 second line reserves.
[8] Additional 53,000 men in reserve.
[9] Includes 600 flying boats.
[10] Includes 1,800 second line reserve.
[11] Includes 600 second line reserve.
[12] Includes 400 second line reserve.
[13] Includes 300 second line reserve.
[14] Number of planes saved from initial campaign and now added to Franco-British forces not known.
[15] Includes 200 second line reserve.
[16] Includes 300 second line reserve.
[17] Includes a large proportion of flying boats.
[18] Data on Spain questionable.
[19] Some sources in Washington credit the Soviet with almost 8,000 military planes of all types.

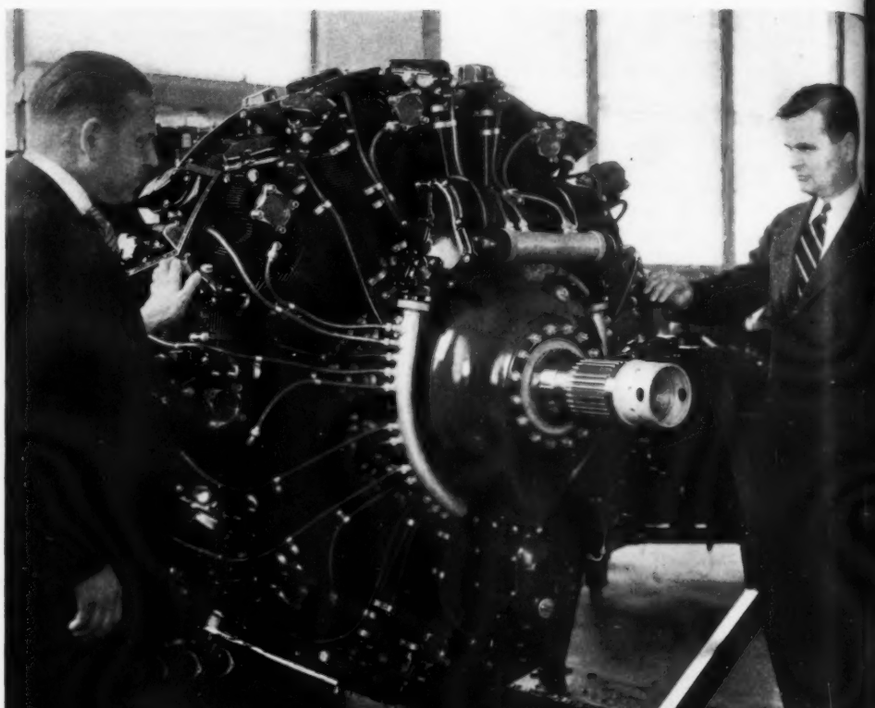
that "not the guns of France or Great Britain or Poland, but the knocking of her airplane motors will toll the doom of Germany in this war." The other faction, with which the writer stands, follows the lead of Dr. Benjamin T. Brooks in asserting that Nazi war plans will not be seriously hampered for lack of petroleum supplies for some time to come.

Disregarding the crude petroleum supplies under control of the Reich, which are used primarily for producing the lubricating oil not obtainable from other sources, as well as the imports from Roumania or Russia, Germany apparently has facilities for the synthetic production from coal of about 29,050,000 bbl. of liquid fuel annually. This comprises for the most part a number of gasoline substitutes, as well as a considerable amount of synthetic Diesel oil. Straight fuel oil of the lighter type produced from coal is not suitable for use in internal combustion engines, but a number of dopes have been evolved which will render it a satisfactory Diesel fuel. Such a dope has been used in Great Britain for several years by Low Temperature Carbonisation Ltd., England's leading coal-oil company.

Colonel Whiston A. Bristow, a coal-oil technologist, well-known for his successful pioneering for that company, stated late in October that the Germans have in view the production of a very high-grade Diesel oil with a cetene number of 120. He then referred to the large quantities of mono-olefines which may be produced by the Fischer-Tropsch process and said that, by synthesis, gases rich in olefines may be produced which can be polymerized into gasoline of high octane value, while vast quantities of methane can be produced by hydrogenation of coal which in turn may be converted and the conversion products likewise polymerized. Just what the Reich may have done by way of erecting plant of the type Colonel Bristow mentioned is not known, but it is evident that a fairly good gasoline may be produced in that country.

A similar instance of synthetic fuels being used satisfactorily outside of Germany may be found in the fact that England's Royal Air Force has been using aviation fuel produced by low temperature carbonisation with satisfactory results. Recalling a statement made to the writer by an Air Ministry official a few years ago, the annual R. A. F. gasoline consumption at that time included about 16,000 bbl. of this type fuel, which was doped to an octane rating of about 85, while a further 14,800 bbl. was derived from benzoles produced by high temperature gas works.

There is not a large supply of aviation blending stock derived from petroleum in Germany, but the Reich does produce tetraethyl lead and other similar dopes suitable for raising the octane rating of the several varieties of coal spirit. These light fuels include gasoline substitutes derived from Bergius hydrogenation, Fischer-Tropsch synthesis, distillation of brown coal and coal tar cracking, as well as quantities of gas works benzole, methanol and alcohol, and they vary widely in their suitability for aviation use.



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Alcohol blends are not satisfactory for general use, and gasoline substitute derived from coal by the Fischer-Tropsch plants in Germany is reputedly low in anti-knock qualities. Catalytic hydrogenation of the Bergius type has proven a reliable source of aviation gasoline, however, because when operating at maximum capacity these plants are said to be capable of manufacturing a fuel of between 70 and 72 octane value, while by limiting the quantity somewhat the quality produced can be raised to about 85 octane, without lead. Addition of dope to the 70 octane base stock will raise it to aviation standard of about 87 octane, but by producing the smaller quantities of high value gasoline and then doping it, performance approaching that obtained with petroleum's 100 octane aviation gasoline might be possible.

Reports would indicate that the Reich prefers to manufacture the larger quantities of aviation fuel rated to correspond with American commercial specifications, for a study of German airplane types has revealed that many have been designed with split tanks to use 87 octane fuel for the take-off and 80 octane gasoline while cruising.

Dr. Brooks states, incidentally, that "an unknown number of planes have been adapted to use benzene blends, by water cooling, thus enabling them to use some 4,500,000 bbl. of benzene for aviation purposes. It is also known that some of the newer types of motors use the forced-injection method, which is also used in Diesel engines, thus enabling them to use gasolines of a wider range of octane and volatility characteristics to much greater advantage."

It is only natural to anticipate that the United States will be called on to supply a large part of French and British wartime demands for aviation gasoline, so that oil companies and refinery construction engineers have been highly active in their efforts toward rapid expansion of existing facilities. There are no complete and reliable data available as to the total producing capacity for all types of aviation gasoline, due to the variety of blending and doping techniques by which it may be produced, but this is to be rectified soon, and the Bureau of Mines has now begun to make a monthly survey of the American aviation gasoline industry. This is accomplished by means of a questionnaire sent to all manufacturers of the product which deals with production, stocks, sales, types produced, and possibility of plant expansions in an emergency. Its purpose is to provide the nation's military and other government officials with information, as well as informing the leading purchasers of this product.

Meanwhile, the oil refiners in the United States, and to an appreciable extent abroad also, are engaged in active expansion of existing facilities and creation of new plant for manufacture of high-octane gasolines by the numerous processes now available.

Such a periodical compilation as that just mentioned is a rather complex proposition, because many of the plants capable of producing commercial iso-octane are blending for high-octane motor fuel rather than aviation gasoline. Even so, because of its high lead susceptibility, 100 octane spirit is customarily produced by blending about

Courtesy U. S. Navy Recruiting Bureau

Left, 18 cylinder, 2,000 h. p. Wright Duplex Cyclone, world's most powerful air-cooled aeroplane engine; and above, squadron of U. S. Navy fighters, important consumers of high-octane fuel.

40 percent of commercial iso-octane with some 10 percent of iso-pentane and 50 percent of straight-run gasoline of 70 to 76 octane, after which it is doped with a small amount of tetraethyl lead. There are about a half-dozen different processes, using raw materials ranging from crude oil to refinery gases, which produce a varied assortment of fuels suitable for blending with straight-run gasoline and which may then be raised to 100 octane without exceeding lead tolerance. Such processes include catalytic polymerization, thermal polymerization, alkylation, catylitic reforming, super fractionation, hydrogenation and hydro-reforming.

Because their greatest value lies in their potentialities for raising the anti-knock rating of straight-run gasoline, in conjunction with tetraethyl lead, rather than for direct use as a high-octane fuel, even when one has the statistics for output of these plants one still cannot calculate to any certainty how much aviation spirit can be produced. For example, one plant using the Houdry catalytic reforming process may produce about 12,000 bbl. of 77.5 octane fuel daily which is increased to a rating of 90 to 92 octane by the addition of 3 cc. of tetraethyl lead per gal. Blended with 30 percent of commercial iso-octane and the same amount of lead will raise the gasoline to a rating of 100 octane by the army method, compared with straight-run gasoline which requires 50 percent commercial iso-octane and 3 cc. of dope to reach that value. By increasing the proportion of tetraethyl lead to 3.75 cc. only 23 percent of iso-octane is necessary, or 20 percent by addition of 4 cc. per gal. Catalytic hydrogenation produces a gasoline by direct polymerization of octenes which has a value of 98 to 100 octane and has a proportionately high blending value. Thermal polymerization distillate has an octane blending value ranging from 80 to more than 100 while neohexane, a new ingredient produced by thermal alkylation, is notable for its unusual response to leading and has a rating up to 100.2 octane upon addition of 3 cc. of tetraethyl lead.

Table V

Comparison of Inspection Data on Safety Fuels and Regular Aviation Gasoline*

Fuel	S.F. No. 1	S.F. No. 2	S.F. No. 3	Regular
Octane Number—				
A. S. T. M. Clear	88	81	....	74
A. S. T. M. +3cc. T. E. L. (1200 r.p.m., 350° F. Jacket Temperature)	92	95	....	87
U. S. Army, Clear	93	77	98	90
U.S.Army +3cc.T.E.L.	99.5	94	106	90
A. S. T. M. Distillation—				
Initial Boiling Point	310° F.	305° F.	235° F.	110° F.
10 percent at	330° F.	323° F.	275° F.	146° F.
50 percent at	345° F.	348° F.	345° F.	187° F.
90 percent at	375° F.	372° F.	350° F.	234° F.
Final Boiling Point	400° F.	401° F.	358° F.	274° F.
Viscosity—				
Centistokes at 100° F.	0.886	1.425	1.550	0.562
Thermal at 60° F., secs.	212	285	...	145
Freezing Point	←	Less than —76° F.		→
Flash Point (Closed Cup)	105° F.	90° F.	95° F.	−10° F.
Gravity, °A. P. I.	30	56.6	53.6	65
Reid Vapor Pressure, Lb. per sq. in.	6	0	0.2	7.0
Acid Heat	3° F.	1° F.	3° F.	1° F.
Sulphur, percent	0.026	0.016	0.26	0.10
Aniline Point	−30° F.	181° F.	183° F.	122° F.
Heat of Combustion—				
B.T.U. per lb. (High)	18,667	20,200	20,230	20,480
B.T.U. per lb. (Low, approx.)	17,700	18,760	18,800	19,100
Heat of Vaporization, B. T. U. per lb.	130	120	118	146

*After T. E. Robertson, Standard Oil Development Company.

Aviation gasoline stocks amounted to about 842,000 bbl. in California and 1,558,000 bbl. in the other states—of which an appreciable proportion was understood to have been sold but awaited shipment. Department of Commerce figures on aviation gasoline exports for the first 10 months of 1939 show declines rather than increases in shipments since the beginning of the European War, apparently due to large supplies laid up during pre-war months: January, 553,000 bbl.; February, 182,000 bbl.; March, 392,000 bbl.; April, 323,000 bbl.; May, 692,000 bbl.; June, 466,000 bbl.; July, 266,000 bbl.; August, 221,000 bbl.; September, 206,000 bbl.; and 287,000 bbl. in October.

With a range of 70 to 100 octanes and having a weighted average of 84, the anti-knock rating of the various grades of aviation gasoline reported to the Bureau was appreciably lower than had been expected, and indicates that a large proportion of fairly low compression engines are still in service.

One of the problems which has been facing refinery research workers in the past few years is the production of low volatility fuels for aviation use. Tendency to operate aircraft at maximum altitudes has been increasing and substratosphere navigation between 20,000 and 25,000 ft. has become feasible. The decrease in atmospheric pressure incident to increased altitudes tends to cause more rapid vaporization, which in turn means loss of the highest octane number fractions in the fuel as well as increasing the fire hazard. Considerable experimentation and development work has been done in the preparation of such aviation gasolines, while adaptation of Diesel power to aeroplanes has revived widespread interest in the use of less volatile fuel in spark ignition engines.

Three so-called Safety Fuels have been developed to meet this military and commercial demand, and their use is now a very active aviation fuel project. Originally developed at the instigation of U.S. Navy engineers for use in lighter-than-air craft, Safety Fuel No. 1 has been in semi-commercial production for a number of years. A comparison of these Safety Fuels and regular aviation gasoline is given in Table V, and the data indicate that No. 3 is superior in every respect. Its heat of combustion is equivalent to that of the ordinary grade and its octane number approaches that of iso-octane while its lead susceptibility is excellent. With a suitable fuel system, this product could probably be used in the most efficient engines developed to-date without any apparent decrease in power or increase in specific fuel consumption.

According to A. E. Robertson, of Standard Oil Development Company, the whole question of fuels for high altitude flying might be summed up by concluding that from the standpoint of freedom from vapor lock and evaporation losses, it will be necessary either to provide special cooling devices with the regular aviation gasoline, or to use less volatile fuels. In case the latter alternative is adopted, safety fuels are particularly advantageous since they assure trouble-free operation in this respect and offer the minimum in fire hazard as well.

If progress in aviation develops along lines which dictate the use of safety-type fuels there is every reason to believe that, judging from the previous history of the petroleum industry, adequate supplies of safety fuel will be made available.

War Held Responsible For Slight Decline In U. S. EXPORTS

Marked Decrease in Shipments During Final Quarter of 1939 Attributed to Disorganization of Trade and Shipping Following Outbreak of Hostilities in Europe.

EXPORTS of crude oil and petroleum products from the United States during 1939 were slightly less than in the preceding year according to statistics of the Department of Commerce. The decrease was approximately 1,000,000 bbl. for eight principal products and was due to a falling off in shipments during the final quarter of the year following the outbreak of war in Europe. Undoubtedly the rationing of fuel both in belligerent and neutral countries, the tremendous rise in ocean transport rates and the shortage of bottoms all contributed to the lessened movement during the latter part of the year.

The effect of the war on exports is indicated by a statement of shipments of principal products by quarters as follows:

	JAN.-MAR.	APR.-JUNE	JULY-SEPT.	OCT.-DEC.
Crude (bbl.)	14,252,601	20,696,329	20,189,137	16,925,857
Gasoline (bbl.)	8,854,791	10,702,817	10,168,250	7,897,907
Light Fuel Oil (bbl.)	6,485,473	8,906,787	8,716,939	6,555,315

While there were reductions in the exports of crude oil, natural gasoline and residual fuel oil, gains were recorded in the shipments of kerosene, light fuel oil, lubricating oil, grease and paraffin wax. A separate classification for aviation gasoline was adopted for the first time in 1939 by the government statisticians and exports of this grade of motor fuel amounted to 4,000,000 bbl. Table I accompanying shows the volume of exports by products over the past three years.

TABLE I

U. S. Oil Exports by Products

	1939	1938	1937
Crude—bbl.	72,063,824	77,271,699	67,127,000
Natural Gasoline—bbl.	4,111,096	6,113,676	3,738,000
Gasoline and other light spirits—bbl.	38,275,310	41,590,000	32,096,000
Aviation gasoline—bbl.	4,000,801		
Kerosene—bbl.	8,494,124	7,262,000	8,664,000
Gas oil and distillate—bbl.	30,618,297	28,295,745	28,993,103
Residual fuel oil—bbl.	14,972,045	15,536,286	12,810,012
Lubricating oil—bbl.	11,864,883	9,312,000	10,899,000
Lubricating grease—lbs.	107,931,066	77,286,039	102,002,000
Liquified petroleum gas—lbs.	13,028,714		
Paraffin wax—lbs.	232,519,030	192,402,077	231,661,220
Bunkers (not included in exports)—bbl.	33,629,577	36,059,000	37,688,000
U. S. vessels	13,284,907	14,217,000	17,234,000
Foreign	20,344,670	21,842,000	20,454,000

In value the exports of petroleum and its products during 1939 at roundly $384,000,000 fell short of the corresponding figure for 1938 by some $4,000,000 but were over $7,000,000 above the value of the smaller shipments of 1937. The decline from 1938 was due in part to the lessened volume of the principal products exported and in part to lower prices realized. Nevertheless petroleum products continue to rank first among the various classes of exports listed by the U. S. Department of Commerce, being approached only by shipments of motor vehicles and parts.

Exports of crude oil suffered a decline of 6.7 percent as compared with 1938. This was due in large part at least to the falling off in purchases by European countries during the final four months of the year. Except as affected by the outbreak of war the crude movement followed its customary lines. Canada remained the largest purchaser of crude and increased its imports from the United States by 3,300,000 bbl. or approximately the same amount as the decrease in 1938 from 1937 imports. Japan continued in second place though buying 5,000,000 less than in 1938. France ranked third, Italy fourth and Argentina fifth as in 1938. Germany, however, fell from sixth place to tenth, partly because shipments to Germany ended with the close of August and partly because Germany, on account of exchange difficulties, had cut down on imports from the United States earlier in the year and was obtaining crude from Mexico under a barter agreement. The United Kingdom, which had reduced its imports of United States crude by nearly 80 percent in 1938, tripled its purchases during 1939 although this trade likewise fell off during the last quarter of the year. Table II shows the ten leading importers of United States crude during 1939 with corresponding figures for the year preceding.

TABLE II

U. S. Crude Oil Exports by Countries of Destination

(Bbl. of 42 U. S. gallons)

	1939	1938
Canada	28,120,634	24,815,141
Japan	16,086,176	21,271,773
France	14,955,253	16,742,506
Italy	4,984,809	6,750,522
Argentina	2,124,955	1,504,255
Cuba	1,140,859	904,988
Kwantung	812,905	916,883
Sweden	639,349	930,225
United Kingdom	555,297	153,028
Germany	415,900	1,287,192

Particular interest attaches to the statistics of exports of aviation gasoline which were separately reported by the Department of Commerce for the first time in 1939. In view of the popular impression regarding the part played by the United States in supplying aviation fuel to warring nations the export total of 4,000,000 bbl. is not especially impressive inasmuch as shipments went to all parts of the world.

More than 20 percent of all exports of aviation gasoline went, surprisingly enough, to the Netherland West Indies which took 50 percent more than any other single country. These shipments undoubtedly were used for blending by the large refineries located at Aruba and Curacao and presumably were re-exported. Among the countries importing aviation fuel for their own consumption France held first place with Japan second and the United Kingdom third.

Aside from the countries shown in the accompanying Table III which were the largest importers of aviation gasoline from the United States the reports show that Mexico was a steady importer of small amounts monthly, taking 32,730 bbl. during the year. Algeria imported 51,000 bbl., Cuba 19,133 and Sweden 18,358. Finland appeared as a purchaser of 46,562 bbl., most of which was taken in November. Hong Kong imported 38,081 bbl. early in the year and Spain imported 33,564 bbl. Germany's purchases amounted only to 23,646 bbl. all of which was taken during the first half of the year. Despite reports that the Soviet Union was obtaining aviation fuel from the United States that country appears as the recipient of only two barrels of this class of gasoline. The Soviet Union did import 883,530 bbl. of other gasoline from the United States during the latter part of the year.

TABLE III

U. S. Exports—Aviation Gasoline

(Bbl. of 42 U. S. gallons)

	1939
Netherland West Indies	904,435
France	645,880
Japan	547,341
United Kingdom	491,481
Italy	213,927
Canada	194,450
Kwantung	151,705
New Zealand	77,585
Netherlands	67,082
Philippine Islands	56,355
Others	650,560
Total	4,000,801

Including shipments of aviation fuel there was a gain of 686,000 bbl. in total exports of gasoline during 1939 as compared with the year preceding. The United Kingdom retained its place as the chief importer from the United States of all grades of gasoline. Germany took only about a third of the quantity imported in 1938 while there were heavy declines in shipments to France, the Netherlands, Canada and Australia. Various other countries which in the past have imported small quantities from the United States increased their takings in 1939. Table IV gives the exports of gasoline to principal

importing countries in 1939 and 1938. The figures for the two years are not strictly comparable because of the separate classification given to aviation fuel in 1939.

TABLE IV

U. S. Gasoline Exports

(Bbl. of 42 U. S. gallons)

	1939*	1938
United Kingdom	7,860,480	8,736,904
Sweden	3,278,779	2,390,504
Nether. W. Indies	2,746,137	3,052,286
Spain	2,093,821	2,052,003
Canada	1,698,456	2,479,596
France	1,671,649	2,927,818
Netherlands	1,446,119	2,122,452
Brazil	1,285,150	1,474,885
Belgium	1,258,259	1,288,382
Soviet Union	883,530	1,120,491
Australia	794,069	2,048,724
Germany	737,099	2,252,888

*Aviation gasoline separately reported in 1939

One branch of the petroleum trade that has been adversely affected by the war, temporarily at least, is the export of natural gasoline. After rising from 3,738,000 bbl. in 1937 to 6,114,000 bbl. in 1938 the shipments of this product fell off to 4,111,000 bbl. last year. Because of its special value as a blending agent the principal markets for natural gasoline are found in countries which have a well developed refining industry. Chief place is held by the Netherlands West Indies and shipments to that colony decreased 296,000 bbl. in 1939 as compared with the previous year. Shipments to the United Kingdom, France and other European countries maintained a normal volume during the first eight months of the year, but fell off abruptly after September 1 when the European war began. Exports to France decreased 80 percent during the final quarter while Great Britain suspended buying entirely. In view of the special adaptability of natural gasoline for improving the quality of ordinary grades of motor fuel it is believed that the decline in the export market is only a temporary one, aggravated by lack of shipping facilities.

TABLE V

U. S. Exports—Natural Gasoline

(Bbl. of 42 U. S. gallons)

	1939	1938
Neth. West Indies	1,503,958	1,799,634
Canada	796,342	799,702
United Kingdom	785,802	1,215,791
France	526,784	856,614
Japan	176,182	384,728
Italy	101,324	12,354
New Zealand	94,359	.....
Norway	81,182	.....
Other	45,163	1,044,853
Total	4,111,096	6,113,676

Export demand for gas oil and distillate increased 8.2 percent in 1939 as compared with the preceding year. Japan was the best market for this product and there was a large increase in the volume of shipments to the United Kingdom and the Netherlands. Germany was a large purchaser until the outbreak of war cut off shipments. With the steady growth in demand for this type of fuel a continuing increase in exports is anticipated with a return to normal conditions. Table VI lists the principal importers of United States gas oil and distillate with comparative figures for 1939 and 1938.

TABLE VI

U. S. Exports—Gas Oil and Distillate

(Bbl. of 42 U. S. gallons)

	1939	1938
Japan	6,020,222	5,297,464
Neth. West Indies	4,843,203	5,110,747
United Kingdom	4,348,822	3,547,765
Germany	3,294,478	4,025,587
Netherlands	2,546,928	2,262,669
Belgium	1,121,828	1,126,093
Panama Canal Zone	1,007,597	928,783
Canada	569,060	562,906
Philippine Islands	561,458	531,602
Denmark	508,754	598,669

Residual fuel oil experienced a slight falling off in 1939 as compared with the high total of 1938 but exports were 2,000,000 bbl. larger than in 1937.

Exports of lubricants advanced sharply in 1939, lubricating oil showing an increase of 27.4 percent and lubricating grease a gain of nearly 40 percent over 1938. Paraffin wax was another product which showed a substantial increase, shipments being 40,000,000 bbl. larger than in 1938 and slightly above those of the previous record year, 1937.

Bunker oil loadings declined nearly 2,500,000 bbl. in 1939 as compared with the previous year and were 4,000,000 bbl. below 1937. Disorganization of shipping during the final four months of the year, due to war in Europe was largely responsible for the decline.

BRAZILIAN PRODUCER

ON January 24, WORLD PETROLEUM received details from the National Council of Petroleum in Brazil regarding Well B.3, which was drilled under the Council's supervision at Lobato, Bahia. Oil sand formations were reached at a depth of 1230/1247 ft. An initial daily production varying from 20 to 50 bbl. was obtained, this output having declined slightly during the swabbing tests which are in progress. The pay was topped at 1230 ft. For the next 17 ft. mostly oil saturated (black-colored) hard, fine-to-medium-grained sandstone, in part hard and calcareous (shell). Very black oil, rather dead; core only partly bleeding with very little gas. Bottom of the oil sand was reached at 1247 ft.

A. HENDERSON has been appointed vice president and sales manager of the McEvoy Company of Houston, Texas. Mr. Henderson has long been identified with the McEvoy Company in the manufacturing end of the business.

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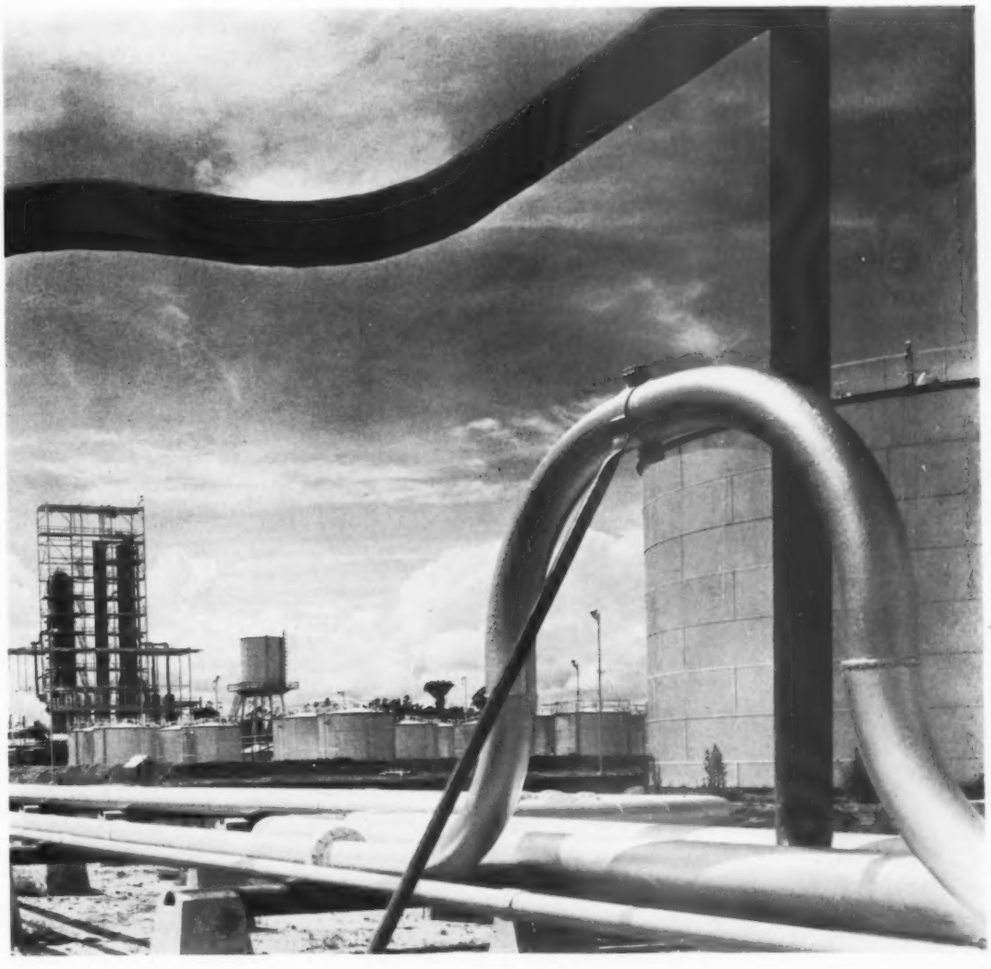


Shell Company's San Lorenzo refinery on the shore of Lake Maracaibo in Venezuela. This refinery treats crude from the Mene Grande field, supplies petroleum products for consumption within the country and has been enlarged within the past year. Photo by Robert Yarnall Richie.

Foreign Oil Legion

W. T. S. Doyle

WILLIAM TECUMSEH SHERMAN DOYLE, general manager of the Royal Dutch Shell Companies in Venezuela, died in Caracas on the morning of January 1, 1940 after an illness of about one month. Mr. Doyle first came to Venezuela in 1913 as assistant to Mr. Procter, then manager of the Caribbean Petroleum Company, became manager of the Shell Companies on Mr. Procter's retirement, and acted in this capacity until December 18th, 1939, when he retired. As manager of the first company to obtain commercial production in Venezuela, Mr. Doyle's career has paralleled the growth and development of the third most important oil producing country in the world. Grief at his death was widespread in social, government and business circles, and his funeral services were attended by the President of the Republic, General Eleazar Lopez Contreras, a number of leading government officials and host of friends.

Mr. Doyle is succeeded as representative of Royal Dutch Shell interests in Venezuela by Mr. Van Hasselt.

William T. S. Doyle was born on April 17, 1876, and was therefore little short of 64 years of age at the time of his death. His father was of Scots descent and moved from New York to California shortly after the famous gold rush of 1849. He was for many years a leading member of the San Francisco bar.

William Doyle completed his studies at the George Washington University, of Georgetown, D. C., from which he was graduated as Bachelor of Arts. After graduation he became connected with one of the leading law firms of the capital. Mr. Doyle had made an especial study of the Spanish language, and this, together with his legal connection, brought him to the attention of the American State Department, by which he was employed on various occasions in the conduct of investigations and negotiations.

When the late Elihu Root, Secretary of State during the Roosevelt administration, planned his famous visit to the South American republics, he selected Mr. Doyle as his private Secretary, by reason of his knowledge of South America and his command of the Spanish language. After Root's return from that tour he desired Mr. Doyle to accept the position of his permanent secretary, but this high compliment was declined in favor of an independent practice of law. Nevertheless, during the administration of President Taft, Secretary Knox appointed Mr. Doyle head of the Bureau of Latin-American republics in the Department of State.

Mr. Doyle resigned his office in the State Department after Bryan became Secretary of State, under President Wilson. He had participated, as a member of the American delegation, in the arbitration of foreign claims against the government of Venezuela in 1903, and later, in December 1908, he came to Venezuela as private Secretary of Mr. Buchanan, President Roosevelt's envoy to negotiate settlement of differences between American claimants and the Venezuelan government. These associations had served to interest Mr. Doyle in the country so that in the year 1913 he accepted an appointment as assistant to the Manager of The Caribbean Petroleum Company, then the pioneer enterprise in the development of Venezuela's petroleum industry.

E. W. FORROW, general sales manager, Security Engineering Co., Inc., left January 26, 1940, on a two months' tour of Venezuela, Colombia, and Trinidad. Mr. Forrow is accompanied by Mrs. Forrow and will be joined in Trinidad by W. C. LANGLEY, Security Engineering Co., representative for that area.

E. W. Forrow

M. Thornburg

M. THORNBURG, director, The Bahrein Petroleum Company, Ltd., and California-Texas Oil Company, Ltd., who left New York for London on business of his companies shortly after the outbreak of hostilities in Europe in September returned to New York in the middle of January. In addition to spending some time in London, Mr. Thornburg visited the Island of Bahrein and the relatively new producing area on the Arabian mainland. Returning to the United States aboard the transatlantic clipper, Mr. Thornburg was held over at the Azores with the other passengers as a result of delays to the aeroplane. When the Italian liner REX stopped at the Azores, the clipper passengers decided to complete their journey on this vessel and arrived in New York on the 13th.

THE NATIONAL COUNCIL OF PETROLEUM in Brazil has appointed one of the foremost Brazilian geologists, ENG. PEDRO DE MOURA, to take charge of geological work in the Atlantic Coast region of that country. Geological studies have been carried out regularly in that area, from Rio de Janeiro to Rio Grande do Norte, but the present intensified drilling activities, proceeding under the supervision of the Council, call for an even more complete geological survey of the region, supplemented by geophysical and micropaleontological investigations, to select the most promising areas for drilling. Mr. Pedro de Moura established his reputation as a petroleum geologist during his work for the Brazilian government in the Amazon Valley and, in 1936, in the Territory of Acré. He subsequently visited the oilfields of Peru and Venezuela. More recently he has been Brazil's technical delegate on the Brazil-Bolivian Commission concerning petroleum.

PROFESSOR VINCENT ILLING and HERBERT C. W. JOHNSTON of Trinidad Leaseholds, Ltd. sailed from New York on January 19 aboard the SANTA ROSA en route for Curacao.

WORLD CRUDE PRODUCTION UP 5.59%

World Production at 2,076,852,000 bbl. for 1939 is 110,265,000 bbl. above 1938 Production — Soviet Union Still Second Largest Producer — Roumania Most Important Country to Show a Decrease, Being 4.9 Percent Below 1938 — Total German Production Increased by 21.5 Percent under Stimulus of Wartime Conditions — Saudi Arabia Shows Greatest Percentage Increase with Canada, Egypt and Albania Making Important Gains.

DESPITE increased difficulties in securing official crude oil production figures during the last quarter of 1939 as a result of upset world conditions, a fairly reliable preliminary picture of world production is presented on this and the following two pages. The general situation may be seen by a glance at the accompanying chart: orange areas indicate countries where production in 1939 fell below the 1938 total. Black areas are countries where increases were recorded.

United States production increased but 4.3 percent compared to an increase of 5.5 percent for the entire world. Producing countries outside the United States registered an increase of 7.6 percent having upped production from 753,333,000 bbl. in 1938 to 810,334,000 bbl. in 1939.

As may be seen from the chart the United States still produces over 60 percent of the world's oil, fractionally less than in 1938. The entire world increased production by roundly 110,264,000 bbl. between 1938 and 1939. The United States contributed 53,263,000 bbl. to this increase and all other countries contributed 57,001,000 bbl. Indications are that not only production but consumption is increasing considerably more rapidly outside the United States than within this country.

In the United States Illinois contributed the most spectacular increase in production. With exploitation increasing rapidly and in the absence of state regulation of production, Illinois has come to occupy an important position among the oil producing states. It is now topped only by California, Oklahoma, Texas and the Gulf Coast area. Moreover, due to its fortunate location adjacent to one of the country's most important consuming areas, Illinois production is responsible for a considerably more potent effect on the U. S. domestic crude market than its 94,057,000 bbl. would warrant, say in the Mid-continent or Rocky Mountain area. There is some question how long Illinois can continue to produce at its present rate without some form of state control to avoid physical waste resulting from too rapid loss of reservoir pressure and other wasteful production practices. However, for the next few years at any rate there appears to be little prospect that Illinois will move from the black to the orange area of the chart.

One other notable fact in the U. S. picture for the past year is the decline in California output, despite the fact that that state also has no machinery embodied in its laws for production control. At least part of the credit for California's failure to contribute to United States overproduction must go to the very effective voluntary control that has been set up by the state's oil producers and which was described in detail by J. R. Pemberton in the July issue of WORLD PETROLEUM.

Outside the United States important changes occurred in Colombia and Venezuela as detailed in the March and December issues of WORLD PETROLEUM.

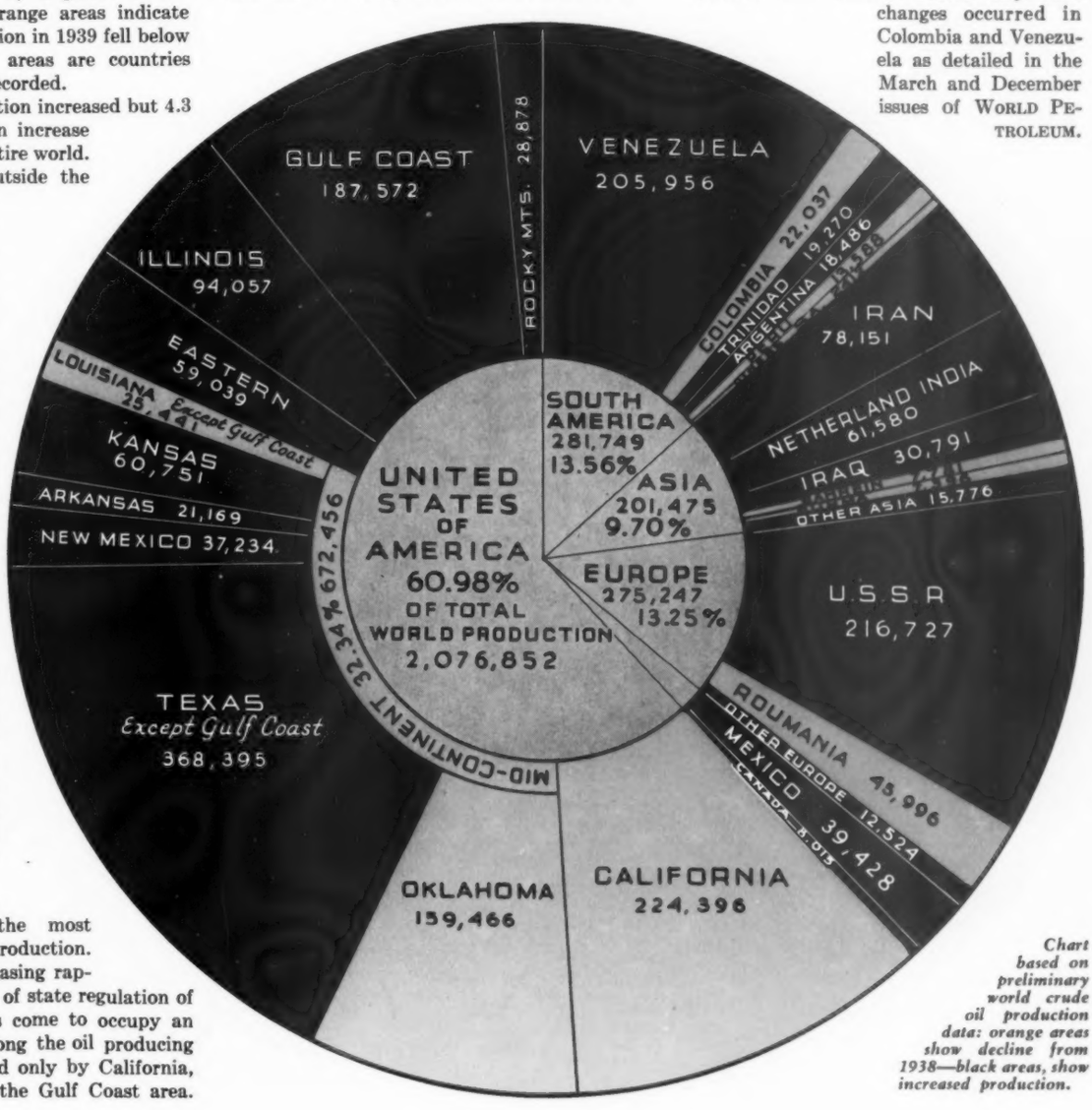


Chart based on preliminary world crude oil production data: orange areas show decline from 1938—black areas, show increased production.

WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified

U. S. BARRELS

	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Nov. 1939	Preliminary Figures Dec. 1939
United States	102,490,000	93,475,000	106,768,000	105,510,000	110,541,000	104,607,000	110,937,000	80,865,000	108,168,000	114,197,800	111,887,000	117,071,500
Soviet Union[4]	17,000,000	17,500,000	18,000,000	18,100,000	18,500,000	18,700,000	18,200,000	18,100,000	18,000,000	18,406,932[1]	17,813,160[1]	18,406,932
Venezuela	16,489,347	14,899,459	15,646,415	16,980,646	17,676,580	16,430,625	18,015,249	18,743,714	18,652,354	17,434,307	16,681,881	17,416,646
Iran[5]	6,402,924	4,978,350	6,992,667	7,237,755	6,801,192	6,341,652	6,637,503[1]	6,637,503[1]	6,423,390[1]	6,637,503[1]	6,423,390[1]	6,637,503
Netherland India: Sumatra	3,129,007	3,113,863	3,393,286	3,401,503	3,602,543	3,498,094	3,557,020	3,550,123	3,502,437	3,600,371	3,389,610[1]	3,502,597
Borneo	1,115,570	1,049,439	1,144,647	1,113,474	1,173,509	1,154,341	1,156,942	1,111,810	865,693	995,207	1,070,760[1]	1,109,210
Java[9]	535,297	527,836	550,097	509,355	530,273	514,565	565,181	559,096	511,355	556,658	528,900[1]	546,530
Ceram	49,200	57,896	67,440	82,914	89,975	77,305	73,962	71,767	68,065	64,292	69,330[1]	71,641
Roumania	3,953,671	3,665,559	3,973,053	3,743,881	3,840,413	3,684,366	3,902,208	3,945,625	3,795,308	3,842,567	3,743,041[1]	3,906,527
Mexico[13]	2,470,000	1,960,000	3,118,021	3,140,120	2,945,000	3,100,000	3,245,000	3,700,000[1]	4,050,000	4,500,000	3,700,000	3,500,000
Iraq	2,422,325	1,961,152	2,699,272	2,608,235	2,663,827	2,721,992	2,807,402	2,615,129[1]	2,530,770	2,615,129	2,530,770	2,615,129
Colombia	1,710,565	1,633,621	1,818,765	1,826,928	1,899,735	1,851,716	1,798,271	1,950,966	1,894,941	1,860,620	1,918,891	1,871,596
Trinidad	1,652,412	1,499,197	1,630,789	1,569,298	1,645,040	1,575,321	1,620,564	1,636,645[1]	1,583,850[1]	1,636,645[1]	1,583,850[1]	1,636,645
Argentine[1]	1,534,000	1,430,000	1,556,000	1,549,000	1,556,000	1,530,000	1,556,000	1,556,000	1,559,683	1,569,933	1,519,290	1,570,032
Peru[8]	1,251,162	1,103,878	1,210,288	1,151,193	1,078,426	1,051,265	1,100,000[1]	1,100,000[1]	1,116,810[1]	1,154,037[1]	1,116,810[1]	1,154,037
Bahrein[6]	647,988	610,766	658,822	629,336	626,009	628,812	671,892	698,714	647,595	660,858	639,540[1]	660,858
Burma[7]	600,863	424,277	698,103	581,633	696,936	665,942	628,153[1]	628,153[1]	607,890[1]	628,060[1]	607,890[1]	628,153
Canada[3]	533,166	358,176	385,273	559,368	713,947	821,308	899,169	795,844	720,866	816,257	731,209	680,729
Brunei[9]	497,324	445,383	492,374	466,328	486,815	464,271	490,318	499,520[1]	474,330[1]	490,141[1]	474,330[1]	490,141
Great Germany: Old Reich[14]	332,601	332,965	396,181	373,126	407,028	373,510	391,098	381,114[1]	368,820[1]	381,114[1]	368,820[1]	381,114
Ostmark[15]	33,634	46,701	43,293	54,375	64,840	74,726	85,131	58,869[1]	56,970[1]	58,869[1]	56,970[1]	58,869
Slovakia and Moravia	10,486	9,000[1]	10,000[1]	9,000[1]	10,000[1]	9,000[1]	11,000[1]	11,000[1]	9,810[1]	10,137[1]	9,810[1]	10,137
Poland	325,093	298,259	333,618	326,436[1]	333,800[1]	318,000	330,000[1]	330,000[1]	320,370[1]	331,049[1]	320,370[1]	331,049
Japan[10]	224,903	218,612	222,386	218,612	221,129	221,128	222,072	210,105	222,513	223,016	223,960[1]	225,370
British India[11]	253,730	213,185	236,042	105,477	127,700	137,070	183,830[1]	183,830[1]	177,870[1]	183,799[1]	177,870[1]	183,799
Ecuador	195,556	171,634	181,938	175,896	193,353	193,710	206,868	204,115	193,720	193,382	196,808	205,132
Saudi Arabia	155,605	170,865	215,270	234,742	281,325	382,932	342,558	350,000	538,136	512,590	313,757	437,020
Sarawak[12]	118,932	100,358	115,990	110,982	112,572	104,224	107,961	113,894[1]	110,220[1]	113,894[1]	110,220[1]	113,130
Egypt[13]	308,946	301,102	330,445	328,376	368,081	425,231	436,519	440,678	362,880[1]	374,976[1]	362,880[1]	374,976
Italian Empire: Albania[16]	99,206	67,914	125,440	244,576	81,839	79,931	140,025	89,000[1]	111,276[1]	117,986[1]	114,180[1]	117,986
Italy	7,511	8,090	8,324	7,792	7,253	7,181	6,843	7,600[1]	7,736[1]	7,750[1]	7,500[1]	7,750
France[1]	42,000	40,000	42,000	41,000	42,000	41,000	42,000	42,000	42,653	42,470	41,160	42,532
Hungary	49,199	49,578	67,261	67,000[1]	70,000[1]	67,000[1]	70,000[1]	70,000[1]	65,210[1]	65,317[1]	63,210[1]	65,317
Bolivia[1]	8,800	7,000	8,700	8,500	8,700	8,500	8,700	8,700	7,893	8,556	8,280	8,556
Other Countries[17]	50,000	35,000	50,000	48,000	50,000	48,000	50,700	50,700	50,000	49,073	47,490	49,073
WORLD TOTAL	166,701,023	152,772,114	173,160,200	173,114,857	179,401,840	171,829,718	180,497,139	151,317,214	177,819,414	184,341,295	178,852,937	186,088,228

[1] Estimated.
[2] Includes natural gasoline (naphtha) production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd., figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Comparative Cumulative Daily Averages in Barrels

	Jan.-Dec. 1939	1938
United States	3,469,910	3,335,421
Soviet Union	593,772	565,905
Venezuela	561,828	505,372
Iran	214,113	210,042
Netherland India: Sumatra	112,987	93,343
Borneo	35,782	34,742
Java	17,630	19,760
Ceram	2,311	1,703
Roumania	126,017	136,309
Mexico	108,022	92,011
Iraq	84,359	86,486
Colombia	60,374	58,304
Trinidad	52,795	47,523
Argentina	50,646	44,655
Peru	37,227	43,777
Bahrein	21,318	23,632
Burma	20,263	20,703
Canada	21,959	19,474
Brunei	15,811	14,431
Great Germany: Old Reich	12,294	10,614
Ostmark	1,899	963
Slovakia and Moravia	327	354
Poland	10,679	10,470
Japan	7,270	6,933
British India	5,929	6,254
Ecuador	6,334	6,176
Saudi Arabia	10,561	243
Sarawak	3,650	4,275
Egypt	12,096	3,369
Italian Empire: Albania	3,806	1,463
Italy	250	297
France	1,372	1,422
Hungary	2,107	709
Bolivia	276	294
Other Countries	1,583	355
WORLD TOTAL	5,687,386	5,422,853

Official Crude Oil Production Figures for 1933 to 1939 in Barrels

	1939	1938	1937	1936	1935	1934	1933
United States	1,266,517,500	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000
Soviet Union	216,727,024	206,192,000	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429
Venezuela	205,956,300	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940
Iran	78,151,332	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075
Netherland India: Sumatra	41,240,454	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172
Borneo	13,060,634	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175
Java	6,435,143	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816
Ceram	843,787	607,622	537,436	375,823	311,872	273,698	285,335
Roumania	45,996,219	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,700
Mexico	39,428,141	38,505,824	46,455,687	41,027,915	40,240,563	38,171,946	34,000,830
Iraq	30,791,132	32,404,000	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915
Colombia	22,036,613	21,581,588	20,297,543	18,756,110	17,597,655	17,337,900	13,156,126
Trinidad	19,270,256	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353
Argentina	18,485,932	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556
Peru	13,587,906	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,311
Bahrein	7,781,190	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377
Burma	7,396,053	7,499,498	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311
Canada	8,015,312	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333
Brunei	5,771,275	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656
Great Germany: Old Reich	4,487,491	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602
Ostmark	693,247	370,038	221,266	50,092	44,347	27,965	5,765
Slovakia and Moravia	119,380	132,005	123,474	126,603	136,580	177,797	121,695
Poland	3,898,044	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079
Japan	2,653,806	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412
British India	2,164,202	2,330,209	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803
Ecuador	2,312,118	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902
Saudi Arabia	3,854,800	495,135	64,968	19,777	Nil	Nil	Nil
Sarawak	1,332,397	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815
Egypt	4,415,090	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535
Italian Empire: Albania	1,389,359	437,597	380,292	219,693	41,218	17,500	11,437
Italy	91,330	106,083	112,700	129,653	128,615	162,449	213,534
France	500,815	516,240	507,067	534,063	529,664	700,000	786,366
Hungary	769,092	330,829	13,910	100	Nil	Nil	Nil
Bolivia	100,885	106,620	123,123	104,746	163,295	157,875	111,973
Other Countries	578,036	243,000	70,000	37,100	32,300	64,000	54,100
WORLD TOTAL	2,076,852,295	1,966,586,845	2,041,169,126	1,797,791,150	1,652,023,331	1,516,760,036	1,438,797,443

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Nov. 1939	Preliminary Figures Dec. 1939
United States	13,866,865	12,647,138	14,445,677	14,275,470	14,956,000	14,153,000	15,009,700	10,941,000	14,635,096	15,450,953	15,138,276	15,839,737
Soviet Union[4]	2,332,000	2,400,000	2,469,000	2,480,000	2,536,000	2,590,000	2,500,000	2,480,000	2,300,000	2,508,024[1]	2,457,120[1]	2,510,814
Venezuela	2,438,207	2,201,782	2,323,150	2,521,254	2,624,585	2,439,598	2,674,870	2,783,031	2,769,466	2,586,268	2,476,894	2,586,268
Iran[5]	849,376	660,400	927,608	960,120	902,208	841,248	880,493[1]	880,493[1]	852,090[1]	880,493[1]	852,090[1]	880,493
Netherland India: Sumatra	420,001	398,651	434,424	435,476	461,214	447,842	455,386	454,503	448,398	460,936	435,870[1]	450,399
Borneo	149,741	134,354	146,543	142,552	150,238	147,784	148,117	142,339	110,830	127,411	138,120[1]	142,724
Java[6]	71,852	67,576	70,426	65,210	67,888	65,877	72,357	71,578	65,466[1]	71,266	68,040[1]	70,308
Ceram	6,604	7,412	8,634	10,615	11,519	9,897	9,469	9,188	8,842	8,231	8,910[1]	9,207
Roumania	536,091	497,025	538,719	507,645	520,734	499,575	529,113	535,000	514,618	521,026	507,531	529,697
Mexico[7]	367,000[1]	287,813	457,859	461,104	432,452	455,212	476,505	543,316[1]	594,713	660,973	543,318	513,950
Iraq	323,797	262,151	360,817	348,648	356,079	363,854	375,271	349,556[1]	338,280	349,556	338,280	349,555
Colombia	238,572	227,841	253,663	254,802	264,956	258,258	247,017	272,101	264,287	257,920	267,627	260,524
Trinidad	232,537	210,857	229,365	220,717	231,370	221,564	227,927	230,206[1]	222,780[1]	230,206[1]	222,780[1]	230,206
Argentina[1]	218,000	202,000	221,000	220,000	221,000	217,500[1]	221,000	221,000	222,177	222,952	215,760	222,952
Peru[2]	166,281	146,286	159,774	151,973	142,367	138,782	146,000[1]	146,000[1]	147,810[1]	152,737[1]	147,810[1]	152,737
Bahrein[3]	88,264	83,180	89,811	85,920	85,353	85,665	91,551	95,348	87,030	89,931	87,030[1]	89,913
Burma[3]	82,992	58,602	96,423	80,336	96,261	91,980	86,738[1]	86,738[1]	83,940[1]	86,738[1]	83,940[1]	86,738
Canada[3]	67,850	45,581	49,029	71,018	90,856	104,518	114,527	101,278	91,736	103,875	93,052	86,614
Brunei[3]	66,410	59,474	65,749	62,271	65,007	61,996	65,474	65,500[1]	63,180[1]	65,286[1]	63,180[1]	65,286
Great Germany: Old Reich[14]	47,562	47,614	56,654	53,357	58,205	53,412	55,927	58,300[1]	53,190[1]	54,963[1]	53,190[1]	54,963
Ostmark[15]	5,014	6,962	6,454	8,106	9,666	11,289	12,691	13,000[1]	9,030[1]	9,331[1]	9,030[1]	9,331
Slovakia and Moravia	1,545	1,500[1]	1,500[1]	1,400[1]	1,500[1]	1,400[1]	1,600[1]	1,600[1]	1,550[1]	1,519[1]	1,470[1]	1,519
Poland	43,000	40,202	44,968	44,000[1]	45,000[1]	41,000[1]	45,000[1]	45,000[1]	42,960[1]	44,392[1]	42,960[1]	44,392
Japan[9]	32,003	31,094	31,631	31,095	31,455	31,454	31,544	31,721	31,651	31,723[1]	31,857[1]	32,209
British India[11]	35,045	29,445	32,602	14,568	17,638	18,932	25,389[1]	25,389[1]	24,570[1]	25,389[1]	24,570[1]	25,358
Ecuador	27,781	22,628	23,986	23,190	25,491	25,539	27,272	26,910	25,540	25,495	25,947	27,045
Saudi Arabia	21,078	23,146	29,161	31,799	38,110	41,037	46,404	47,500	72,899	72,899	42,503	59,201
Sarawak[13]	15,199	13,848	14,823	14,183	14,386	13,329	13,797	14,539[1]	14,070[1]	14,539[1]	14,070[1]	14,539
Egypt[12]	44,008	43,002	47,193	46,897	52,568	60,730	62,342	62,936[1]	51,810[1]	53,537[1]	51,810[1]	53,537
Italian Empire: Albania[16]	14,869	10,179	18,801	36,657	12,266	11,980	20,987	13,000[1]	16,678[1]	17,639[1]	17,070[1]	17,608
Italy	933	1,005	1,034	968	901	892	850	950[1]	961[1]	961[1]	930[1]	961
France[1]	5,900	5,500	6,000	5,700	6,000	5,700	6,000	6,000	5,983	5,983	5,790	5,983
Hungary	6,619	6,670	9,049	9,000[1]	9,500[1]	9,000[1]	9,500[1]	9,500[1]	8,773[1]	8,804[1]	8,520[1]	8,804
Bolivia[1]	1,100	900	1,000	1,000	1,000	1,000	1,000	1,000	1,023	1,023	990	1,023
Other Countries[17]	7,000	6,000	7,000	6,700	7,000	6,700	7,100	7,100	7,000	6,975	6,750	6,975
WORLD TOTAL	22,830,296	20,893,818	23,679,527	23,683,751	24,546,773	23,527,544	24,698,838	20,772,620	24,134,307	25,209,774	24,483,085	25,441,589

[3] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[13] Sarawak Oilfields, Ltd., figures.
[12] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
[18] Official Figures—Petroleos Mexicanos.

Comparative Cumulative Daily Averages in Metric Tons

	Jan.-Dec. 1939	1938
United States	469,439	447,815
Soviet Union	80,994	79,332
Venezuela	83,945	74,687
Iran	28,403	27,780
Netherland India: Sumatra	14,529	12,534
Borneo	4,604	4,663
Java	2,268	2,652
Ceram	297	228
Roumania	17,087	18,206
Mexico	15,874	13,170
Iraq	11,276	11,597
Colombia	8,404	8,126
Trinidad	7,426	6,688
Argentina	7,193	6,368
Peru	4,927	5,764
Bahrein	2,901	3,170
Burma	2,798	2,874
Canada	2,794	2,460
Brunei	2,106	1,883
Great Germany: Old Reich	1,773	1,514
Ostmark	301	155
Slovakia and Moravia	49	52
Poland	1,432	1,379
Japan	1,039	982
British India	818	863
Ecuador	840	875
Saudi Arabia	1,440	32
Sarawak	469	561
Egypt	1,727	481
Italian Empire: Albania	569	216
Italy	32	36
France	193	198
Hungary	284	91
Bolivia	33	36
Other Countries	225	50
WORLD TOTAL	777,924	737,152

Official Crude Oil Production Figures for 1933 to 1939 in Metric Tons

	1939	1938	1937	1936	1935	1934	1933
United States	171,358,912	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191
Soviet Union	29,562,958	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100
Venezuela	30,580,000	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193
Iran	10,367,112	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093
Netherland India: Sumatra	5,303,100	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352
Borneo	1,680,753	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849
Java	827,844	933,595	960,125	499,097	464,757	510,320	483,331
Ceram	108,528	81,560	72,139	50,446	41,862	36,738	38,300
Roumania	6,236,774	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000
Mexico	5,794,035	5,716,423	6,896,657	6,090,842	5,973,955	5,666,857	5,049,109
Iraq	4,115,845	4,345,000	4,126,185	4,079,066	3,724,231	1,048,108	147,943
Colombia	3,067,568	3,007,935	2,844,251	2,614,092	2,452,635	2,416,432	1,833,606
Trinidad	2,710,515	2,472,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532
Argentina	2,625,281	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499
Peru	1,798,557	9,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867
Bahrein	1,059,014	1,130,734	1,058,557	635,555	173,072	39,008	4,293
Burma	1,021,426	1,039,960	1,083,391	1,047,593	991,456	1,004,951	982,233
Canada	1,019,934	876,016	378,430	190,495	182,820	178,233	144,686
Brunei	768,813	707,123	576,545	470,991	471,842	386,478	290,808
Great Germany: Old Reich	647,337	552,074	453,451	444,600	427,400	317,500	238,600
Ostmark	109,904	63,468	33,010	7,473	6,616	4,172	860
Slovakia and Moravia	18,103	19,282	18,036	18,665	19,946	25,971	17,776
Poland	522,874	504,678	501,301	510,630	614,760	529,200	550,670
Japan	379,437	356,328	341,040	341,976	326,580	266,520	212,667
British India	298,895	322,125	298,450	273,137	281,072	265,341	224,879
Ecuador	306,824	319,877	306,326	275,293	245,434	231,947	229,578
Saudi Arabia	525,737	66,683	8,070	2,447	Nil	Nil	Nil
Sarawak	171,322	200,126	217,085	221,126	253,799	277,513	315,259
Egypt	630,370	223,058	166,298	177,491	176,436	214,671	232,437
Italian Empire: Albania	207,734	65,313	56,760	32,760	6,152	2,500	1,707
Italy	11,346	13,178	14,000	16,106	15,977	20,180	26,526
France	70,539	72,106	71,008	74,788	74,172	98,025	110,120
Hungary	103,739	42,798	13,910	13	Nil	Nil	Nil
Bolivia	12,059	13,262	15,487	13,197	20,540	19,858	14,085
Other Countries	82,300	34,080	10,000	5,300	4,600	9,100	7,700
WORLD TOTAL	284,105,489	277,989,582	279,482,914	246,449,340	226,610,486	207,971,753	197,034,849

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOPHYSICS

Magnetism of Geological Bodies — F. Bahnemann, in BEITRAGE ANGEWANDTE GEOPHYSIK, Vol. 7 (1939), No. 3, pp. 281-284.

Lately great interest has been aroused in the application of magnetic measurements for obtaining information on sub-surface structures and for locating mineralized bodies. Insofar as magnetic anomalies are supposed to be attributable to the presence of magnetic minerals, the author points to the increasing number of results which can be related with the induction theory only with difficulty or, in many cases, not at all. A number of outstanding cases in South Africa point to mechanical forces playing an important rôle in the magnetization of geological bodies, and the theory that the anomalies result from a reversal of the earth's field must be rejected. In experimental physics the effect of elastic distortion on magnetization long has been known, and it is suggested now that the anomalies found in the field are the result of shear and strain.

Geophysical Exploration—Sherwin F. Kelly in MINING AND METALLURGY, vol. 21 (1940), No. 397, pp. 41-44.

This is a review of geophysical processes and work in 1939, covering various fields as well as the petroleum industry. As regards the latter, a striking feature is a marked decrease in the number of seismic crews employed, although the percentage of oil-company crews appears to have been increased. Two years ago there were probably over 100 such crews in the Gulf Coast area; now there are only about 35. There are various explanations, including the effect of low petroleum prices, a growing scarcity of appropriate new territory, and perhaps a natural shrinkage following a period of overoptimism. However, all likely regions have not yet been structurally mapped. The principal improvements in seismic technique have related to improvement of the geophones, reduction of size and weight of units and reduction in the number of laborers required.

In gravimeters, use is being made of an instrument for surveying areas covered with water; the instruments are lowered to the bottom but are read at the surface; operations can be carried on at depths of 50 feet, with expectations of going deeper. On land the gravimeter is definitely displacing the torsion balance; crews operating the latter have decreased from thirty to three within the past two years, whereas gravimeter crews have increased from 18 to 75. But the torsion balance still retains its preeminence for detailed work when it is desired to obtain gradient and curvature values. Considering the whole world, there are probably 250 gravimeters at work, practically all in oil explorations. At present most gravimeter operations in the United States are confined to the Mid-Continent, and east of the Mississippi.

A new technique has been developed for utilizing the natural earth currents to deduce basement complex patterns, utilizing discharges of several thousands of volts. In this way it has been possible to map West Texas prospects where usable seismic reflections were difficult to obtain. It is likely that electrical prospecting may increase in importance for oil exploration. Gamma-ray logging is increasing in use and may prove a supplement if not a substitute for Schlumberger technique. The magnetic method is still showing usefulness in tracing old shore lines and locating faults, and the findings have been confirmed by drilling.

Soil analysis in petroleum prospecting is attracting a good deal of attention. The industry has been slow to accept this method, and no recent spectacular discoveries have been credited to it. However, the opinion has been expressed that, owing to the growing scarcity of structural traps and the necessity for developing methods for detecting stratigraphic traps, the oil industry must resort to soil analysis and electrical surveying if it wants to find more oil.

Geothermal methods are becoming increasingly recognized as an important adjunct in petroleum exploration, as these often throw light on the presence, shape, type and age of geologic structures and the fluid content of rocks. Aside from oil exploration, the author shows that there is also going on an immense amount of work in connection with metal mining and for various other purposes of subsurface study.

GEOLOGY

On Recent Sediment Formation in Concepcion Bay (Chile)—H. Falke, in PETROLEUM, Vol. 35 (1939), No. 35, pp. 658-665.

The following phenomena are of annual occurrence in Concepcion Bay. At the beginning of the southern summer, plankton multiplies greatly in the sheltered water, and later dies. Decomposition of the remains gives rise to hydrogen sulfide in such quantities that the odor is perceptible several miles inland. At this stage migrating swarms of squid enter the bay and are killed by the poisoned water. Later on swarms of fish meet the same fate. With the approach of winter a shift in shore currents removes the polluted water, but the same series is repeated the following spring. Investigation of the sediments of the bay shows the presence of a clay ooze containing up to 14 percent of organic matter, in which are found perceptible amounts of fatty substances and even matter analogous to bitumen.

The author agrees with previous investigaotrs that this locality is a place where a mother substance capable of ultimately becoming a source of petroleum is now being produced by natural processes.

Possible Criterion for Distinguishing Marine and Non-Marine Sediments—A. J. Crowley, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939) No. 11, pp. 1716-1720.

The author calls attention to what appears to be an important aid in classifying and correlating geological formations according to the manner of their origin. In examining a large number of sediments of known non-marine origin it was noted that in none of these sediments was there found any secondary-growth feldspar either as a cement in aggregates of feldspar and quartz grains, as euhedral crystals, or as a secondary growth on clastic feldspar grains, except where such cases exhibited evidence of being broken and abraded in transport. On the other hand, in each case, in the writer's experience, without exception, the marine sediments exhibited either (1) well formed euhedral crystals of feldspar, (2) new growth about a nucleus of clastic feldspar, or (3) aggregates of feldspar and/or quartz grains cemented by secondary-growth feldspar.

DRILLING

Mud Analyses Used to Log Wells by Drilling—W. A. Sawdon, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 12, pp. 84, 86.

A new method for determining the content of subsurface formations while they are being drilled and of logging the depth and thickness of these formations has recently been made available for general use. Based on the fact that the oil, gas, or salt water content of any formation drilled by the bit will be carried to the surface by the circulating fluid, the content of any unit volume of the drilling mud can be disclosed by tests made at the surface. Employing a method of correlating the analysis disclosed by the tests with the depth of hole at the time the unit volume was passing the bit, it is thus possible to determine whether the particular part of the formation being drilled contains gas, oil, or salt water and the relative quantities contained.

More than 40 wells have been drilled using this method, which is now known as the Baroid well logging service.

This logging method depends on arrangements whereby the composition of the circulating fluid at the moment it passes the bit at the bottom of the well can be determined. By timing the action of the mud pump, that is, by pumping at a constant rate, it is easy to correlate a sample of the mud with the bottom of the hole at the time. The operator of the logging arrangement is equipped with instruments for detecting as little as 0.25 percent of gas in the mud stream; crude oil is detected by means of ultra violet light, and salt water by electrical conductivity. It has been found that gas may be detected while the bit is still 15 or 20 feet above the oil or gas sand.

The main object of this service is to obtain a more perfect log of the well, especially as to the content of oil, gas and salt in the formations that

are being penetrated. It has further been found that the stroke counting attachment on the mud pump gives a valuable warning of washouts or underground leaks, the beginning of which are usually not sensed by the driller but which may have serious consequences if the pipe is not pulled in time.

It has also been found when readings are slow that the walling properties of the mud are poor and caves are being washed in the walls of the hole. On the other hand, when the readings are fast there is an indication that circulation may be too slow or that the mud is not sufficiently thick to carry the cuttings to the surface. Such a condition should be corrected to eliminate the hazard of stuck drill pipe.

Test of Large Drilling Equipment—W. A. Sawdon, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 12, pp. 95-96; 98, 100, 102, 104, 106.

Two 11,500 ft. holes were drilled in the Rio Bravo field, California, with heavy equipment designed for drilling to 18,000 to 20,000 ft. depths, should attempt to reach such depths become necessary in the future. The equipment was therefore more amply dimensioned than would have been necessary for the wells actually drilled. The steam raising plant is especially powerful, consisting of five boilers generating steam at 500 lbs. pressure, which is probably a record in oil drilling. The derrick is 175 ft. high on a 32-ft. base; the draw works, crown block and traveling block permit the use of a 1½ in. wire line instead of 1¼ in., which is the largest to date. These derricks have a load capacity of 500 tons. The draw works are designed for higher speeds than any now in use, speed being obviously essential in deep drilling. The ensemble has operated with an efficiency that promises success when real deep drilling is attempted.

Overcoming High Pressure—Anon. PETROLEUM WORLD, Vol. 36 (1939), No. 8, p. 28.

High pressure water sands are characteristic of the Lost Hills field (Calif.) where conventional cementing methods have failed in certain conspicuous instances. The present paper relates to a well bottomed at 8,320 ft. where a 150 lb. mud was necessary to keep out salt water. It became necessary to seal off the salt water, and as in two attempts ordinary cement failed to hold, use was made of a product of the U. S. Gypsum Company known as Cal-Seal, which proved successful.

The Tachometer—Odometer in the Illinois Field—Drilling Committee, in Progress Report, A. P. I., 1939.

Reference is made to an instrument for recarding speed of revolution and footage by rock bits. The instrument is identical with the speedometer-odometer used by the automotive industry, except that it records total revolutions. The instrument is mounted at any convenient point outside the derrick to minimize vibration and at the same time be in full view of the driller, and is connected to the rotary-table pinion shaft by means of a 25-ft. length of flexible shafting. The operation of the unit is entirely automatic, there being no reset device on the odometer, and it is accumulative up to 100,000,000 revolutions.

The character of the information obtained is illustrated as follows: When using an 8¾ in. rock bit the best run per bit was 749 ft. immediately under the surface pipe and made a total of 129,000 revolutions. This is an average of 5.81 ft. cut per 1,000 revolutions. One bit was worn out after it made a total of 54,000 revolutions, but during this time it had made 107 ft. of hole, or 1.98 ft. per 1,000 revolutions. Another bit made a total of 137,000 revolutions while cutting 102 ft. of hole. This amounts to 0.75 ft. per 1,000 revolutions and for an 8¾ in. bit represents the least amount of hole cut per 1,000 revolutions. Several runs on a 4⅞ in. bit are shown and the number of revolutions and footage made by the bits are very much less than in the case of an 8¾ in. bit. It is hoped that by the use of such data the following conclusions can be drawn:

1. Determination of optimum rotative speed for various phases of drilling operations; 2. Determination of optimum rotative speed for various formations; 3. Determination of best type and make of bit; 4. Defining bit life with greater accuracy; 5. Improved correlations of all factors which may affect drilling rates.

This instrument has not been in use long enough to permit recommendations at this time, but it has been in operation long enough to reveal the potentialities that may be realized in the future.

Effect of Temperature on Plastering Properties and Viscosity of Rotary Drilling Muds—H. T. Byck, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 4, Technical Publication No. 1116; 8 pages.

A survey of the literature on rotary drilling muds clearly shows the growing realization of the importance of plastering properties, not only from the point of view of the successful completion of the mechanical operation of drilling the well but also from the point of view of minimum impairment of the natural flow possibilities of a given well.

Poor plastering properties with attendant high filtration rate (large water loss to the formation) and thick mud sheath, lead to stuck drill pipe, difficulty in landing casing, etc., and may promote certain types of heaving when the water filters into bentonitic and related formations. Furthermore, the penetration of water together with fine colloidal matter into the oil-bearing sand may have a marked influence upon the rate of subsequent production of oil from that sand.

The plastering properties of six representative California drilling muds were studied over a temperature range of 70° to 175° F. at several mud weights, using a high-pressure circulating filter press with full size consolidated cores. In all tests, with untreated as well as with chemically treated muds, the filtration rates at elevated temperature were higher than at low temperatures and in nearly every case this increased filtration rate was notably larger than could be attributed alone to the decreased viscosity of water—the flowing medium—at elevated temperatures.

It is concluded that no existing method will permit even an approximate determination of the filtration rate at high temperature from data at room temperature. It is necessary to measure filtration at the temperature actually anticipated in the well, or to make a sufficient number of tests at various lower temperatures so that a small extrapolation of these data to the anticipated well temperature may be applied. Such tests should be carried out on the mud as actually used in the well.

The viscosity of each of the muds was determined over the same temperature range. While no relationship was observed between mud viscosity and plastering properties, it was found that chemical treatment of the muds for viscosity reduction shifted the temperature of minimum viscosity to appreciably higher values than for untreated muds.

The six California muds each gave a different curve of filtrate versus temperature, which shows that it will be necessary to determine a curve for each mud, and under the conditions of actual use. There did not appear to be any relation between mud viscosity and plastering properties of these muds.

OPERATING

Removing Dissolved Gas from Fluid in Pumping Wells—H. Lee Flood in PETROLEUM ENGINEER, Vol. 11 (1939), No. 2, pp. 27-28.

After an oil well has ceased to flow from gas pressure there remains the frequent disadvantage that the oil still contains enough gas which, in escaping from solution, is a cause of "gas locking" that interferes with pumping operations. This inconvenience has lately been overcome by a mechanical bottom-hole separator which in effect is an agitator that shakes the gas out of the oil and separates it in a manner such that it does not cause trouble. Incorporating simple and rather obvious principles, the mechanical bottom-hole oil-gas separator makes use of the slight vibration inherent in the tubing string of every pumping well to actuate a series of dashers or agitators, each of which rests on a light coil spring. The resulting agitation in the gas-laden oil simply churns the oil and, assisted by the decreased pressure also occurring in the bore of virtually every oil well, hastens the rate at which the gas is liberated from the oil.

The device has been installed in something more than 300 wells and a survey of the results shows that gas-locking has generally been reduced. Another result is that there is less trouble from sand as the oil does not remain still long enough for sand to settle in the pump. A further result is a decrease of paraffin trouble. Rod loads are said to be reduced.

Electric Submersible Well Pump Performance—W. H. Stuve, in PETROLEUM ENGINEER, Vol. 11 (1939), No. 3, pp. 38, 40-41.

In the St. Louis pool, Oklahoma, oil is produced from an average depth of 4,100 ft. and has 61 wells equipped with Reda electric submersible well pumps lifting fluid at the average rate of 1,700 bbl. a day.

The main point appears to be that in the experience of many operators the conditions in many wells in the St. Louis pool require pumping at as high a rate as possible in order to obtain profitable operations. Many large capacity wells, when producing at the rate of about 400 bbl. per day, yield only water and a negligible amount of oil, yet, were the same wells pumped at a rate of 1,400 to 1,700 bbl. per day or greater, the percentage yield of oil to water would increase by as much as 9 or 10 percent.

Oil Mining Possibilities in Pennsylvania—Parke A. Dickey, in PENNSYLVANIA TOPOGRAPHIC AND GEOLOGIC SURVEY, Progress Report No. 123 (1939), 31 pages.

The possibility of recovering oil by underground mining in Pennsylvania became a live subject in 1939. In most of the Pennsylvania fields the gas pressure has been so dissipated that only small quantities of oil are produced per well. Much of the oil still remains in the sands. This oil is of very superior quality and commands a price double that of most western oils. The oil sands are at comparatively shallow depths.

Early attempts at mining oil are extensively discussed. Existing oil mining practice at Pechelbronn, France and in Hannover Province, Germany, are described. Numerous proposals that have been made are reviewed, and some experimental work that has been done in Pennsylvania is discussed.

In view of all the facts it is the opinion of the author that the recovery of oil by underground methods of mining is technically possible, and that under favorable conditions it will be profitable. The method of drilling horizontal holes from the foot of a shaft seems to offer the cheapest way of opening a large surface of oil sand to drainage, and is, therefore, the most promising of the methods proposed. However, it presents many technical difficulties, especially in the methods of producing the oil after the wells are drilled, which will have to be worked out by experiment.

It cannot be overemphasized that any oil mining project should be undertaken only by a group with large resources, able to acquire a large block of rich land, to use the best technique of mining and petroleum engineering, and to carry the project to a successful conclusion despite unforeseen difficulties. A group without large resources is almost certain to fail, and one or two failures might retard the progress of the oil industry in the State by many years.

CHEMISTRY

Gum Formation in Cracked Gasolines—D. L. Yabroff and E. L. Walters, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 32 (1940), No. 1, pp. 83-88.

The authors started out from a proposition to the effect that the most rational procedure of determining the gum-forming tendency of a cracked gasoline would be to measure the gum content at various periods of time when it is heated at various elevated temperatures. A curve would be obtained from which it could be predicted what the gum content would be at various temperatures and storage periods.

After considerable experience they have been led to a confirmation of this proposition. Their experimental gasolines were heated with oxygen in a bomb at various temperatures and for various times. It turned out that the rate of gum formation during approximately the first 90 percent of the induction period was exponential; a plot of the logarithm of the gum content of the gasoline against the time of oxidation yielded straight lines for each of the several temperatures investigated.

Expressing the time of oxidation of the gasoline at the various temperatures as a percentage of its induction period at the temperature involved indicates that the rate of gum formation is affected by temperature in essentially the same manner as is the induction period. Accordingly, after a gasoline has reached a given percentage of its induction period through accelerated oxidation, the amount of gum thus formed should be nearly independent of the temperature of the oxidation.

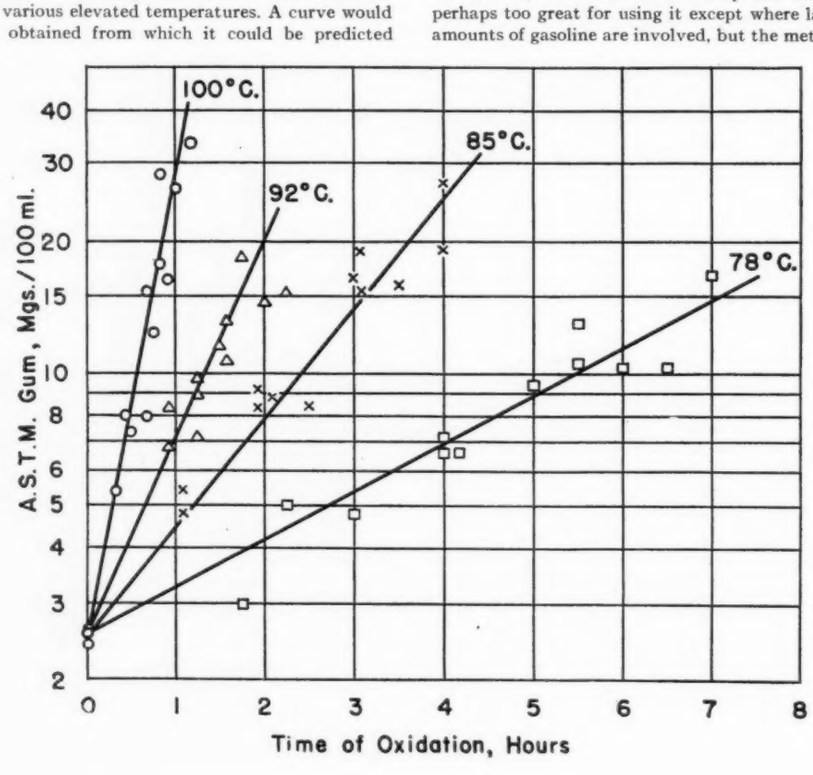
It is then to be expected that the effect of temperature on the 10-mg. gum time may be expressed by an equation of the same form as for the induction period.

$$\log tg = A + B/T$$

where tg = 10-mg. gum time, hours
T = absolute temperature, °K.
A, B = constants which depend on the gasoline (this equation may be used for computing times to reach gum contents other than 10 mg. per 100 ml., in which case intercept A will have a different numerical value but B will be unchanged)

Any given gum time may be computed from the initial gum content and the 10 mg. gum time for a given set of conditions so long as the rate of gum formation obeys the above logarithmic function.

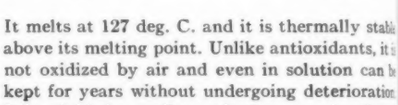
However, the time consumed by the test is perhaps too great for using it except where large amounts of gasoline are involved, but the method can be used effectively in determining the relative efficacy of various refining treatments, in comparing gasolines from various stocks, etc.



Suppression of Metal Catalysts in Gasoline Gum Formation—F. B. Downing, R. G. Clarkson and C. J. Pedersen, in OIL & GAS JOURNAL, Vol. 38 (1939), No. 11, pp. 97-101.

Gasolines often contain autogenous catalysts generally thought to be peroxides or monoxides which are responsible for the deterioration (gum formation) of the stored gasoline. In practice the attempt is made to counteract this tendency by treating the gasoline with inhibitors, or substances that will prevent or inhibit the formation of gum. On the other hand the inhibitors themselves are subject to catalytic destruction by other catalysts that may find their way into the gasoline; among these counter-catalysts is copper, with which gasolines are frequently brought into contact during manufacture and subsequent handling. Hence, in addition to a gum inhibitor, the finished gasoline may well be treated with a counter catalyst to deactivate copper.

The deactivator whose action is described in this paper is disalicylalethylenediamine, obtained by condensing two mols of salicylaldehyde with a mol of ethylenediamine. Its structural formula is:



It melts at 127 deg. C. and it is thermally stable above its melting point. Unlike antioxidants, it is not oxidized by air and even in solution can be kept for years without undergoing deterioration. It is soluble in gasoline and other organic solvents and resists extraction by water. It has no deleterious effect on other gasoline addition agents, such as dyes and tetraethyl lead.

The action of a metal deactivator on a copper contaminated gasoline inhibited with hardwood tar distillate and p-benzylaminophenol is shown in the following table:

THE EFFECT OF COPPER DEACTIVATOR

No.	Antioxidant—	Conc. wt. percent	— Induction pd. in min. — No. added Cu	1 p.p.m. Cu	1 p.p.m. Cu + 0.0[illegible] percent deactivator
1	None	....	110	30	110
2	Hardwood-tar distillate	0.015	200	50	300
3	*p*-Benzylamino-phenol	0.001	270	45	430

It will be observed that 0.001 percent or 10 p.p.m. of copper deactivator completely eliminated the effect of copper. In fact, the response of the anti-oxidants was higher in the presence of the de-activator plus copper than in the absence of added copper.

Numerous tests have demonstrated that the deactivator will at least negative the effect of copper even if it will not always cause the increase shown above. It was also found that all gasoline antioxidants, such as the xylenols, catechol, alpha-naphthol, pyrogallol, *p*-phenylenediamine, and the different derivatives of *p*-aminophenol, will behave in the same manner. Hence, in the following portion *p*-benzylaminophenol will represent the gasoline antioxidants.

It has been determined that 5 to 10 parts by weight of these deactivators are required to suppress the catalytic activity of one part of soluble copper irrespective of the concentration of copper, whereas 40 to 1,000 parts of the antioxidants, depending upon their efficiency, are necessary to perform the same task in the range of 1 to 10 p.p.m. of copper.

Not all gasolines show an improvement from treatment with a deactivator, but the improvement in many cases is such as to warrant tests. Copper sweetened gasolines are especially likely to contain the gum-inhibitor poison.

PHYSICS

The Determination of Friction Characteristics of Lubricating Oils—A. W. Burwell and J. A. Camelford, before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

An apparatus is described for the determination of friction characteristics of lubricants under controlled conditions of temperature, speed, pressure, and surface conditions, using a partial journal bearing system of bronze on steel. A considerable degree of accuracy is claimed for the apparatus, agreement to within two percent being obtained for check tests.

Friction data are given for a series of oil blends with naphthalene, alpha-naphthol, alpha-naphthylamine, and alpha-nitronaphthalene, together with the friction characteristics of the petroleum stock used in making the blends. These figures tend to show that the additions have deleterious effects on the lubricating ability of the oil, despite the fact that these substances have been advocated for improvements of certain characteristics of lubricants in service.

Viscosity Index of Lubricating Oils—E. W. Dean, A. D. Bauer and J. H. Berglund, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 32 (1940), pp. 102-107.

A need exists for basic constants in kinematic as well as Saybolt units and for the extension of the scale to lower values. The present paper reports the preparation and availability of a table of kinematic constants covering the range of 2.0–75.0 centistokes (equivalent to 32.8–349 Saybolt seconds) at 210° F. The new table, except for a slight revision in the range corresponding to 40–50 seconds Saybolt at 210° F., is equivalent to that previously published according to the relation between kinematic and Saybolt viscosities that has been approved by the American Society for Testing Materials. The constants covering the range from 2.0–4.2 centistokes at 210° F. are new material.

Nomographic charts have been prepared by which viscosity indexes can be estimated conveniently. These charts may be obtained from Standard Inspection Laboratory, 26 Broadway, New York.

REFINING

Steels for Oil-Synthesizing Plants—F. K. Nanmann, in PETROLEUM, Vol. 35 (1938), No. 36, pp. 678-687.

The growing importance of hydrogenation in the treatment and reforming of oil refinery products, and especially in the high-temperature high-pressure oil synthesis from coal now extensively practiced in Germany, has put special requirements on the steels used in constructing the apparatus employed in these processes. These steels must not only have the necessary high tensile strength at high temperatures and resistance to hydrogen sulphide, but they must also have the special property of resistance to hydrogen, which has a distinct corrosive property of its own at elevated temperatures.

The author gives a lengthy description of a series of experiments conducted at the Krupp works on the problem of hydrogen-resistant steels. It turned out that the desired resistance was furnished by steels containing 3 to 6 percent of chromium, which also have a satisfactory resistance to hydrogen sulphide. It was established that this resistance was due to the presence of the chromium in the form of a carbide. This suggested that other carbide forming metals would confer the same resistivity. This proved to be the case with vanadium and titanium. For instance, a steel with 0.1 percent of carbon, 0.5 percent of titanium or 0.6 percent of vanadium has a resistance to hydrogen equal to that of a 6 percent chromium steel.

The advantage of titanium and vanadium in this connection lies in their relative cheapness.

ASPHALT

Asphalt-Origin, History, Development—Its Relation to Petroleum. By Joseph Rock, Draney; issued 1939 by ASPHALT INSTITUTE New York; 32 pages.

This booklet reviews the history of asphalt from the time of the discovery of the Trinidad asphalt lake. It gives a lively account of the development of the asphalt paving industry and the later rise of the petroleum industry as a supplier of asphalt and as an increased source of supply of this important raw material.

Asphalt Paving Materials, Analysis and Forecast—N. F. McCoy and Prevost Hubbard, in RESEARCH SERIES, ASPHALT INSTITUTE, No. 5 (1939), pp. 1-8.

The status of the asphalt paving industry, past and present is reviewed, particularly on the specification side. Of interest to asphalt manufacturers is the forecast for the future.

Numerous reports on the excessive hardening of asphalts after a few years service permit one prophecy without resort to the imagination; namely, that softer asphalt cement will be used for "high type" paving, and that cutbacks with somewhat softer residues may be demanded for low cost roads. There is even now a discernible tendency to substitute the more viscous slow curing liquid asphalts for cutback asphalts in certain types of work. Both dense and open-graded plant-mixes using an extremely soft asphalt cement known in the Western States as SC-6 liquid asphalt have been built recently by Western State and Federal authorities that were using cutbacks for that purpose two or three years ago.

Finally, laboratory control of bituminous surfacings will be more positive. Tests of the various combinations of asphalt and minerals that will be used, devised to simulate field conditions, and correlated with service results are becoming increasingly more revealing.

Solvent Extraction of Bitumen from Asphaltic Rocks—Luigi Freda, in PROCEEDINGS ITALIAN NATIONAL FUEL CONVENTION, Rome, 1939, pp. 257-259.

Semi-industrial plant operations show that 95 percent of the soluble bituminous matter contained in Italian asphaltic rocks can be extracted by a crude grade of trichloroethylene. About six kilograms of solvent are lost per ton of material treated. Power required to pulverize the rock and do the necessary pumping and solvent recovery is 4 kilowatts per ton; heat consumption is 43,000 metric calories per ton. The extraction is carried out under pressure at 80° to 110° C. When hydrogenated the extracted bituminous substance yields 80 percent of its weight of gasoline. The cost is in excess of the cost of the imported product, but from the national autarchic standpoint, and as provider of employment in non-industrialized districts, the process is worth subvention by the government.

USES

Carbon Disulphide from Methane and Hydrogen Sulphide—H. I. Waterman and C. van Vlodrop, in JOURNAL SOCIETY CHEMICAL INDUSTRY, Vol. 58 (1939), pp. 109-110.

Experiments were made by passing mixtures of methane and hydrogen sulphide through quartz tubes at ordinary pressures and temperatures ranging from 1,080 deg. to 1,280 deg. C. When the original gas mixture consists of approximately two volumes of hydrogen sulphide to one volume of methane the main reaction follows the equation:

$$CH_4 + 2H_2S = CS_2 + 4H.$$

The best results are obtained when the reaction mixture contains about 70 percent of hydrogen sulphide. With such a mixture the yield of carbon disulphide is a maximum (75 percent of the theoretical yield), and the production of secondary products (carbon, free sulphur and tar-like substances) is at the minimum.

Note.—The oil industry has plenty of methane and hydrogen sulphide; the consumption of carbon disulphide is large (artificial silk and insecticides) and might become larger if the cost of present methods is appreciably reduced.—Ed.

A Simple Motor Test Method for Diesel Fuels—H. H. Neumann, pp. 614-621.

The author gives a description of a motor method for testing Diesel fuels developed by Rhenania-Ossag. The method is based on the German Ordnance Motor (H W A motor), but may be adapted to any one of the commonly used American, Dutch or other standard motors. The principal feature of the equipment is an accurate time-recording device.

SUBSTITUTES

Fifty Thousand Kilometers on Alcohol as Motor Fuel—A. L. Teodoro, in PHILIPPINE AGRICULTURIST, Vol. 58 (1939), No. 2, pp. 99-119.

A report is made of experiences in driving a private car for a period of five years using alcohol as motor fuel. The engine behavior as regards starting, acceleration, power, engine wear, corrosion, and mileage under different driving conditions was noted.

The De Soto De Luxe Sedan (1929 model) used in this study performed very satisfactorily when run for over 50,000 kilometers on alcohol fuels for a period of five years. No difficulty in starting was encountered except when the engine carburetion and ignition systems were faulty and when the driver improperly used the choke. Constant operations were maintained at various loads and speeds. As much power as could be produced with gasoline was obtained with alcohol fuels. No

sticking of the valves or of the piston rings was noted. Fuel passageways that were made of galvanized iron rusted.

The mileage increased as the amount of gasoline in the mixture was increased. The decrease in mileage due to extra fuel consumed for starting the car, idling, backing, and to losses by evaporation and leakage if any, varied from 5 to 16 percent.

Proper utilization of nearly straight alcohol as motor fuel demands care not only in properly adjusting the carburetion and ignition systems of an engine but also in manipulating the parts which control these systems so as to bring about smoothness in engine operation, great power, and maximum fuel economy.

ECONOMICS

The Future of Gasoline and the Automobile—Graham Edgar, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 31 (1939), No. 12, pp. 1439-1446.

The primary object of this paper is to give an account of tetraethyl lead, its manufacture and use.

For the purposes of this abstract the most interesting and important part of the paper is a report of some road tests made by the General Motors Corporation, which carried out an elaborate research project to determine the possibilities of increasing compression ratio under conditions in which the antiknock value of the fuel was no longer the limiting factor. An automobile equipped with a valve-in-head engine was selected for the investigation. The car was operated both on the dynamometer and on the road at a number of compression ratios and a number of gear ratios, and fuels were used which in each case were just capable of avoiding knock. The octane numbers of these fuels are a little uncertain since neither they nor the octane number requirements were determined by the conventional C. F. R. method, but approximately 69 octane fuel was required for the standard 5.25 compression ratio, about 95 octane number for 8.0 compression ratio, and something better than 100 octane number for 10.3 compression ratio.

The data of these tests appear clearly in the accompanying graph.

The results are striking and show, for example, that at 40 miles per hour the miles per gallon improved from 12.5 at 5.25 compression ratio to 18 at 8.0 and 21 at 10.3. The average increase in economy, between 10 and 60 miles per hour, is about 45 percent in going from 5.25 to 8.0 compression ratio under these conditions of constant performance. If we take the average retail price of gasoline as 19 cents per gallon, the driver of the 8.0 compression car could have paid 27.5 cents per gallon at no increase in cents per mile, which would give the refiner a margin of 8.5 cents per gallon above his regular costs of 5 cents per gallon with which to attempt to produce the 95 octane gasoline required by the high compression car. Such an achievement would appear to be well within the eventual possibilities of the refinery technologist.

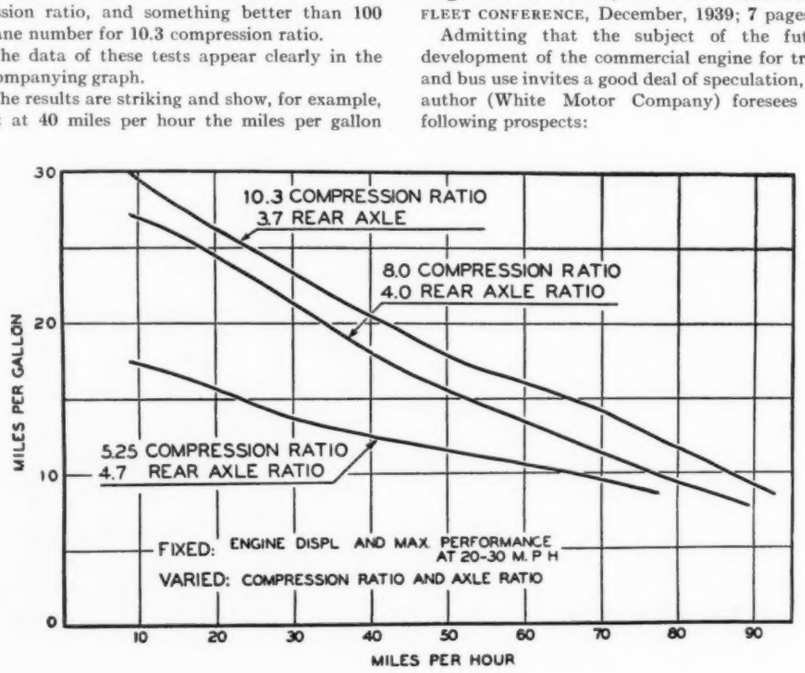
It was also shown that by supercharging, the economy of gasoline may be further very considerably increased.

The general upshot of this highly interesting research is that both the gasoline and the automobile industries are ready to enter a broad new phase of public service. By combining high octane and high compression, the motorist may ride more miles with no increase in fuel cost. In another sense this new technological development has a significant bearing on the conservation of petroleum resources. It has been computed that with a 60 percent increase in engine efficiency, and supposing that the public would not increase its present total automobile mileage, gasoline requirements would shrink correspondingly, which would be reflected in an extension of the life of our proven oil reserves. Thus, an increase in average mileage per gallon from 12.5 to 21 would save an amount of crude oil equivalent to the product of more than 5000 new oilfields, each capable of yielding a million barrels.

It is held that this General Motors Corporation research has definitely shown that a suitably designed automobile engine can profitably use gasoline of the highest available octane number. This indicates that in no long time the oil refining industry will be turning out 100 octane number gasoline as its regular product.

Future Development of the Commercial Engine—Robert Cass, before NEW YORK ETHYL FLEET CONFERENCE, December, 1939; 7 pages.

Admitting that the subject of the future development of the commercial engine for truck and bus use invites a good deal of speculation, the author (White Motor Company) foresees the following prospects:



For general truck use the six-cylinder engine will continue to be the most satisfactory type of engine, and for large capacity buses, the twelve-cylinder engine of the horizontal type offers the best economical development.

Cubic inch displacement for a given horsepower output as compared to present standards will be reduced. Already changes have been effected in this direction. Today a 362 cubic inch engine is successfully operating with output and general performance equal to that of an engine 100 cubic inches larger. This trend will continue.

The need will become evident for engine performance to flatten out the hills for over-the-road trucks. Present well designed engines are capable within legal restrictions of hauling loads on the level at possible and safe operating speeds but satisfactory speed on grades for reduction in terminal-to-terminal time can only be achieved by increased horsepower. Legislation may accelerate such development.

Fuel economy—Future development of fuels, such fuels to be marketed at a relatively slight increase over existing fuel costs, indicates a gain in fuel economy in the future, perhaps as much as 45 percent.

With the same fuel development, naturally, very much increased Brake Mean Effective Pressures will be secured but a number of problems of material and design will call for a good deal of development to be successful.

Engines will cost more for a given piston displacement as compared to present engines, but the price per horsepower will be lower.

Diesel fuels—There appears to be a limit to the improvement in Diesel fuels. Gasoline does not have the same limitations. A further limiting factor in the use of Diesel fuels is the ever present possibility, as they increase in use, that taxation and other leveling factors in relation to price will occur. In any case, it seems possible that specific fuel consumption of gasoline engines will ultimately be much lower than present Diesel engines with the distinct possibility of a lower fuel cost per mile.

Air cooled engines—Development of the air cooled engine for truck and bus use in the next few years will be confined to small specialty delivery type vehicles and light commercial vehicles.

All this adds up to a conviction that the gasoline engine is due for some really startling developments in the next few years.

Note—The technological base for this prophecy regarding gasoline will be seen in the preceeding abstract of the paper by Edgar on the future of gasoline and the automobile.—Ed.

GENERAL

Certain Facts on the Petroleum Situation of the Third Reich—M. Friedwald, in REVUE PETROLIFERE, No. 868, (1939), pp. 1399-1400; 1402-1403.

Many attempts have lately been made to evaluate the oil situation in Germany but many of these studies seem to lack the objectivity necessary for drawing positive conclusions. One of the latest of these studies has been made by a British authority (Underwood), who estimates current production in Germany, including natural oil and all oil substitutes, at 4,300,000 tons, which it is said will be extended to 6,550,000 tons during 1940.

In the present contribution to the subject the author takes exception to Underwood's estimate.

He analyses all available official statistics and reaches the conclusion that at the 1939 peacetime rate of consumption Germany needs about 8,750,000 tons of petroleum products, comprising 3,500,000 tons of motor fuel, 2,000,000 tons of gas oil and 660,000 tons of lubricants. What the wartime consumption is or may be it is impossible to say; the international experts who have studied the matter have guessed from 15 all the way to 30 million tons, but these guesses have left out consideration of the character of the war on the rate of oil consumption for military purposes. While hostilities are confined mostly to a state of siege as at present, oil consumption will presumably be much less than in a war of motion.

At any rate, the Germans will certainly not consume more oil than they can get their hands on; the main point is then to find out how much they can get. There is first the production of the domestic oil fields, which in 1938 yielded 608,742 tons and was probably 700,000 tons in 1939. The small oilfields that fell to Germany in the partition of Poland may yield another 135,000 tons. A liberal estimate will allow the Germans a total production of about 1,000,000 tons of natural petroleum. As to synthetic petroleum, which is used chiefly for motor fuel, it seems that in 1940 this source will yield 2,200,000 tons. The 1938 production of benzol, which can be used as motor fuel, was 525,000 tons, but most of this will now certainly go into the production of explosives, leaving perhaps 250,000 tons as motor fuel in 1940. For much the same reason only about 100,000 tons of alcohol will be available for mixing with gasoline. Perhaps about 165,000 tons of motor fuel can be saved by using compressed gas and charcoal for running omnibuses, etc., and another 235,000 might be saved through the use of lignite and coal tars.

All this foots up to about 3,950,000 tons as the petroleum resources which Germans actually have under their hands. Any additional supplies must come from the outside. It does not appear that more than 1,500,000 tons a year, if that much, can be obtained from Roumania, which would bring the available supply to about 5,450,000 tons a year, or a deficit of 3,300,000 from the 8,750,000 tons consumed annually in peace time.

The sole remaining possible source of supply is Russia. This country produces around 30,000,000 tons of petroleum a year, but in 1938 had an export surplus of only 1,000,000 tons, and is now undoubtedly consuming or storing all it produces. Even if Russia had an export surplus of 3,000,000 there is an obvious lack of transport facilities.

Note.—This estimate was made before the Germans acquired from Russia the right to produce oil from the fields of eastern-Poland, which are now Russian; in 1938 the Polish production was about 560,000 tons. Another factor not taken into account is the severe restriction on automobile traffic in Germany, which means that most of the gasoline formerly used by civilians is now commandeered for military use. An editorial in the German oil journal Oehl und Kohle (December 15, 1939), commenting on these foreign guesses about Germany's oil supplies, states that in 1940 the synthetic petroleum industry will be expanded to the point of meeting all possible requirements of the Nazi war machine.—Ed.

Flue-Gas Protection for Ships' Tanks—O. W. Johnson, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 189, pp. 426.

Because of the large investment and concentration of risk, tankers engaged in carrying volatile

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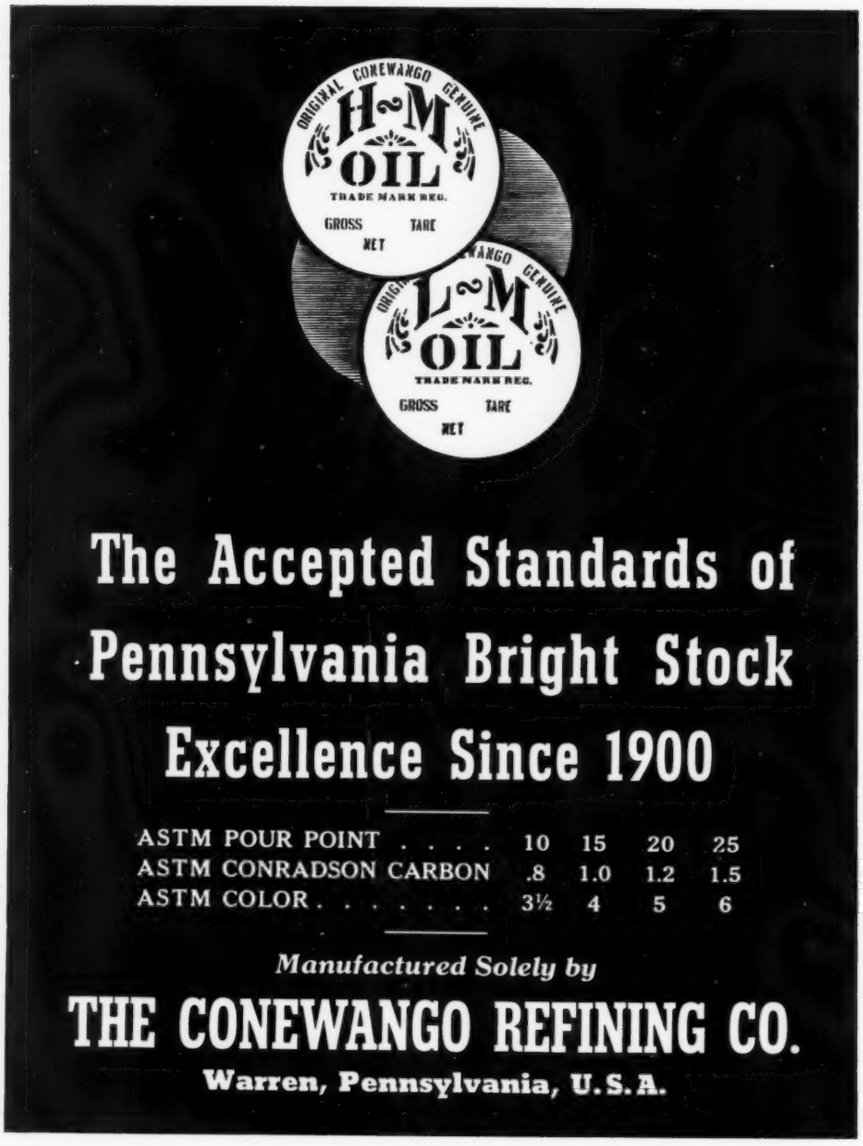

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petroleum products offer an extra hazard from explosion and fire, and special precautions have been taken to protect them from these hazards. The manner of formation of explosive mixtures in ships' tanks is reviewed, and it is shown that most of the danger from explosion can be avoided by excluding air from the tanks, supplying in its stead an oxygen-lean flue gas, to take the place of the oil when cargo is discharged.

The equipment which makes up a complete flue-gas system, and the manner of operation, are briefly described.

Experience has shown that the revised operating routine required on a flue-gas-equipped ship is easily acquired, and that operators are in general appreciative of the greater ease of handling and improved conditions. The pressure made available is a distinct aid to getting suction on ships' cargo pumps, and is a virtual necessity when handling casing-head gasoline cargoes having high vapor pressure.

It is pointed out that without some special equipment the presence of explosive mixtures in ships' tanks at certain times is the rule rather than the exception, and that it appears unwise to place the full burden of avoiding accident on the enforcement of safety rules, particularly since some sources of ignition may be beyond the control of operators. The use of flue gas offers a means of providing additional safety. In view of the important operating advantages and the general improvement of conditions, the expense of a flue-gas system is believed to be warranted.

Production of Petroleum Resins—S. C. Fulton and A. H. Gleason, before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

In addition to the naturally occurring resins which nearly always are present in crude oil in small amounts, resins also may be formed during the processing of these oils and by direct synthesis.

Cracking-coil tar resins may be recovered by absorption but it has been found preferable to subject the tar to distillation and solvent extraction. Treatment of the reduced tar with metallic halides is especially advantageous both for increasing the yield and causing separation of undesirable constituents.

Petroleum distillates, particularly those of high aromatic content, may be condensed with formaldehyde to form useful resins. Less highly aromatic stocks may be partially converted to resinous material by chlorination followed by dehydrohalogenation either at elevated temperatures or with metallic halides.

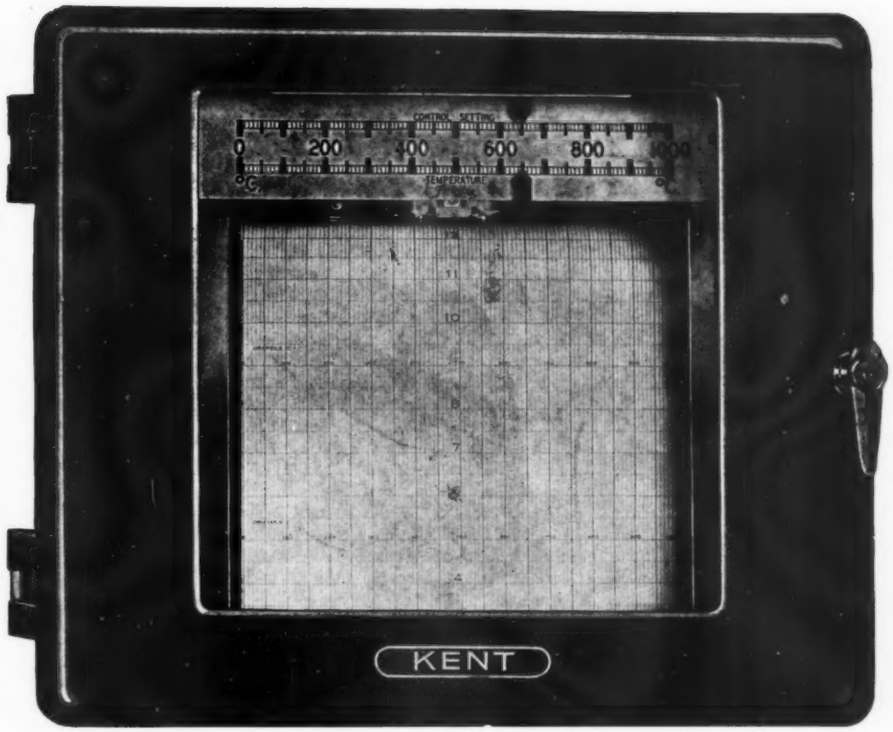
GREEK EXPLORATION

(Continued from page 25)

began to realize what even big operators consider "real money," Golden Meadow, University, Garden Island, Quarantine Bay, St. Martinville and Grand Bay.

Records of the Louisiana department of conservation credit Helis and his Canal Oil Company with bringing in 25 completed oil wells during the nine months from January through September of 1939.

(Continued on page 52)



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Daily initial production ranged from 113 to 175 bbl. and averaged better than 307 bbl. totaling 7,694.

The Helis activities in Greece have extended over a year period and have included a geophysical survey which is being continued. It was on his return to New Orleans at the end of 1938 that Mr. Helis announced his acquisition of the concession for oil development in his native land, where Herodotus, in his history, wrote the first known description of an oil field and told how oil was used to light the flares of the early Olympic games.

In March 1939 he sent drillers from the Iberia field to start development work in Greece under the supervision of his son. Two rigs were sent abroad—one a light exploratory rig to make core tests; the other a Franks model 4000 AC portable rotary mounted on a heavy truck and powered by two Diesel engines, with a mast capable of supporting 112,000 lbs. of drill stem or pipe.

The latter rig had been used in the Iberia field both for drilling wells to 5,000 ft. and for re-working to the same depth. It has proved as fast as a regular standard rig, according to Helis, and is more economical to operate. He predicts, incidentally, the extensive use of portable rigs for dry land drilling along the Louisiana coast.

Two geologists and paleontologists and a chemist are with the exploratory crew. The site selected for the first Helis wildcat in Greece is near the Ionian seacoast on the western side of the Peloponnesian peninsula south of the Gulf of Corinth, about 15 miles from the city of Pyrogos. The location is about 250 miles south of Athens, near Olympia and within sight of the island of Zante where Herodotus 2,600 years ago visited the celebrated pitch springs of Zacynthus.

Helis's contract with the Greek government calls for the latter to receive eight percent of all oil recovered and provides that the oil produced may move out of Greece duty free. A clause in his contract gives him the right to use American labor, and he is not required to construct roads or other public works in conjunction with his operations.

The geology of Greece according to Helis' explorations, corresponds closely to that of the California coastal areas. The Kettleman Hills area provides a close analogy to what he expects to find in his development work abroad. In addition to favorable geological structure, numerous surface indications of oil and gas exist.

Oil manifestations in Greece are mainly confined to strata of Miocene age the thickness of which can only be determined by drilling such as is now being carried on. Aside from the showings of oil reported to have been found at a depth of something over 4,000 ft. in the test well previously mentioned a gas well said to yield 20,000,000 cu. ft. per day was reported from the same district. So far as announced no conclusive proofs as to the existence or non-existence of commercial oilfield has been obtained but the opinion of those who have followed his career in Louisiana is that if there is oil in Greece Bill Helis will find it.

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